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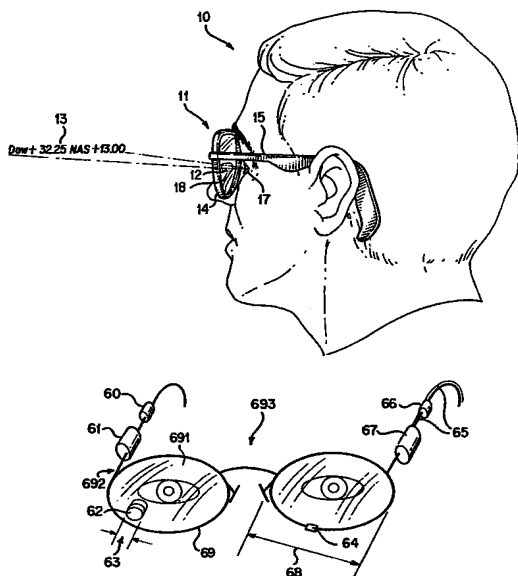
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(57) Abstract: In accordance with the present invention, an integrated method and apparatus for communication is provided. In one embodiment, a head-mounted viewable display system for a user is provided. This system includes eyewear (11) and a micro-optical display (12). The micro-optical display (12) is positioned in the field of vision of the user and is configured to correct a portion of the refractive error of the user. In another embodiment of the present invention, an integrated communication system is provided. This communication system contains a head mounted frame, a speaker (66) mounted to the frame, a lens mounted to the frame, a micro-optical display (62) having a micro-character display supported by the frame, a microprocessor (60) supported by the frame, and a wireless communication device mounted on the frame, the wireless communication device in communication with the microprocessor. In still another embodiment of the present invention, a method of displaying information to a user is provided. This method includes displaying a first line of characters on a micro-optical display having a micro-character display and using an optical element to project the first line of characters in the field of vision of the user.

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## **Integrated Method and System for Communication**

### **Related Applications**

This application claims the benefit of: U.S. Provisional Application No. 60/144,728, filed July 20, 1999; U.S. Provisional Application No. 60/150,544, filed August 25, 1999; and, U.S. Provisional Application No. 60/164,873, filed November 12, 1999. All of these above listed provisionals are incorporated herein by reference.

### **Field of the Invention**

The present invention relates to methods and systems for communication. More particularly the present invention regards an integrated communication system capable of providing visual and audible information to a user while the user is participating in other activities.

### **Background of the Invention**

The integration of computers into our daily lives has increased substantially over the last several decades. Main frame computers, once the only source of computing power, have evolved into desktop units, lap top units, Personal Digital Assistants (PDA's), and, now, wearable computers. In each one of these evolutionary steps, the computers have become smaller and more easily accessible.

Wearable computers may be computers which suspend a visual display in the field of view of a user. Known wearable computers contain a headset physically

connected to a processing unit. These headsets provide visual information to a user in the form of a full or quarter screen computer display. As can be imagined these existing display units are somewhat large, unwieldy, bulky, and utilize an exposed connecting wire to a battery pack and/or processor worn on one's waist. Their size is in part due to the power and data transfer rates required to reproduce a quarter or more of the display screen of a typical computer monitor. These large power and data transfer rates have worked to buoy the size and cost of wearable computers.

Concomitantly, over these same decades, wireless communication networks have been created and have, understandably, shaped the daily lives of individuals throughout society. Wireless networks have connected people in ways never before thought possible. Previously inaccessible individuals now have access to one another and to information in a more timely and accurate fashion through the use of cellular phones.

Cellular phones, which transmit and receive information over today's wireless networks, have become smaller and less costly while at the same time have continued to offer a longer range and more services. Not only may these known cellular phones be used in wireless telephony but they may also be used in other applications as well. For example, certain known cellular phones currently offer Internet access.

Despite this increase in available services and their reduction in size known cellular phones continue to suffer from the same infirmities as those from the past. For example, in order to view information from the Internet which is displayed on a known cellular phone a user must hold the phone at some distance from their eyes while within their field of vision and must divert their attention to the display on the cellular phone to see the displayed information. Consequently, users are unable to perform other tasks while viewing the information displayed on the cellular phone.

While it is foreseeable that the use of wearable computers and wireless telephones will continue to increase, under their current design paradigms they will nevertheless suffer from the conceptual shortcomings experienced today.

### **Summary of the Invention**

In accordance with the present invention, an integrated method and apparatus for communication is provided. In one embodiment, a head-mounted viewable display system for a user is provided. This system includes eyewear and a micro-optical display. The micro-optical display is positioned in the field of view of the user and is configured to correct a portion of the refractive error of the user.

In another embodiment of the present invention an integrated communication system is provided. This communication system contains a head mounted frame, a speaker mounted to the frame, a lens mounted to the frame, a micro-optical display having a micro-character display supported by the frame, a microprocessor supported by the frame, and a wireless communication device mounted on the frame, the wireless communication device in communication with the microprocessor.

In still another embodiment of the present invention a method of displaying information to a user is provided. This method includes displaying a first line of characters on a micro-optical display having a micro-character display and using a first optical element to project the first line of characters in the field of vision of the user.

### **Brief Description of The Drawings**

Fig. 1 is a side perspective view of eyewear worn by a user in accordance with an embodiment of the present invention.

Fig. 2.0 is a front perspective view of the eyewear of Fig. 1 in accordance with an embodiment of the present invention.

Fig. 2.1 is an exemplary view of a line of characters as seen by a user looking into the micro-optical display mounted on the eyewear illustrated in Fig. 2.0.

Fig. 2.2 is a front perspective view of a Processor Communication Control and Storage Unit (PCCSU) in accordance with an alternative embodiment of the present invention.

Fig. 2.3 is a view of an Integrated Communication System being worn by a user in accordance with another alternative embodiment of the present invention.

Fig. 3 is a comparison of a full VGA field of view, a quarter VGA field of view, and the field of view of an exemplary micro-optical display in accordance with another alternative embodiment of the present invention.

Fig. 4.0 is a view of a single line of text as displayed by a micro-optical display in accordance with another alternative embodiment of the present invention.

Fig. 4.1 illustrates multiple rows of text of various lengths filling the field of view of a micro-optical display in accordance with another alternative embodiment of the present invention.

Fig. 4.2 is a view of a picture displayed in the circular field of view of a micro-optical display in accordance with another alternative embodiment of the present invention.

Fig. 4.3 is a picture having a rectangular field of view as displayed in a micro-optical display in accordance with another alternative embodiment of the present invention.

Fig. 5.0 is a view of two lines of text displayed on a micro-optical display in accordance with another alternative embodiment of the present invention.

Fig. 5.1 is a view of a single line of text displayed on a micro-optical display in accordance with another alternative embodiment of the present invention.

Fig. 5.2 is a view of two lines of text displayed on a micro-optical display in accordance with another alternative embodiment of the present invention.

Fig. 5.3 is a view of three lines of text displayed on a micro-optical display in accordance with another alternative embodiment of the present invention.

Fig. 6 is a front perspective view of eyewear in accordance with another alternative embodiment of the present invention.

Fig. 7 is a front perspective view of eyewear in accordance with another alternative embodiment of the present invention.

Fig. 8 is a front perspective view of eyewear in accordance with another alternative embodiment of the present invention.

Fig. 9 is a side view of the eyewear from Fig. 8.

Fig. 10 is a front perspective view of eyewear in accordance with another alternative embodiment of the present invention.

Fig. 11 is an enlarged view of a micro-optical display in accordance with another alternative embodiment of the present invention.

5        Fig. 12 is an enlarged view of a rib cage structure from the micro-optical display of Fig. 11.

Fig. 13 is an enlarged view of the rib cage structure of Fig. 12 showing some of the components that may be placed within the rib cage structure.

10       Fig. 14 is a side view of a micro-optical display in accordance with another alternative embodiment of the present invention.

Fig. 15.0 is an enlarged perspective view of a micro-optical display positioned near a user's eye in accordance with another alternative embodiment of the present invention.

15       Fig. 15.1 is an enlarged view of axis markings located on the micro-optical display of Fig. 15.0.

Fig. 16.0 is an enlarged perspective view of a micro-optical display in accordance with an alternative embodiment of the present invention.

Fig. 16.1 is a mirror adjustment chart as utilized for the micro-optical display of Fig. 16.0 in accordance with an alternative embodiment of the present invention.

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Fig. 17 is an enlarged perspective view of a micro-optical display positioned near a user's eye in accordance with another alternative embodiment of the present invention.

25       Fig. 18.0 is a side view of a micro-optical display in accordance with another alternative embodiment of the present invention.

Fig. 18.1 is a side view of a micro-optical display positioned near a user's eye in accordance with another alternative embodiment of the present invention.

Fig. 18.2 is a side view of a micro-optical display positioned near a user's eye in accordance with another alternative embodiment of the present invention.

Fig. 18.3 is a side view of a micro-optical display in accordance with another alternative embodiment of the present invention.

Fig. 18.4 is a side view of a micro-optical display in accordance with another alternative embodiment of the present invention.

5        Fig. 18.5 is a side view of a micro-optical display in accordance with another alternative embodiment of the present invention.

Fig. 18.6 is a side view of a micro-optical display in accordance with another alternative embodiment of the present invention.

10       Fig. 18.7 is a side view of a micro-optical display in accordance with another alternative embodiment of the present invention.

Fig. 18.8 is a side view of a micro-optical display in accordance with another alternative embodiment of the present invention.

Fig. 19 is a front perspective view of eyewear in accordance with another alternative embodiment of the present invention.

15       Fig. 20 is a front perspective view of eyewear in accordance with another alternative embodiment of the present invention.

Fig. 20.1 is a front enlarged view of an eyewire and micro-optical display in accordance with another alternative embodiment of the present invention.

20       Fig. 20.2 is a front enlarged view of a notched lens in accordance with another alternative embodiment of the present invention.

Fig. 21 is a side view of eyewear in accordance with another alternative embodiment of the present invention.

25       Fig. 22 is an enlarged perspective view of a micro-optical display mounted on a lens in accordance with another alternative embodiment of the present invention.

Fig. 23 is a rear view of eyewear frames in accordance with another alternative embodiment of the present invention.

Fig. 24 is a front perspective view of eyewear in accordance with another alternative embodiment of the present invention.

Fig. 25.0 is a side view of the eyewear from Fig. 24 in accordance with another alternative embodiment of the present invention.

Fig. 25.1 is an enlarged cutaway view of a lens in accordance with another alternative embodiment of the present invention.

5 Fig. 26 is an inside view of eyewear as seen by a user in accordance with another alternative embodiment of the present invention.

Fig. 27 is a side perspective view of eyewear in accordance with another alternative embodiment of the present invention.

10 Fig. 28 illustrates an emergency response system in accordance with another alternative embodiment of the present invention.

Fig. 29 is a front perspective view of a charging data link unit in accordance with another alternative embodiment of the present invention.

## 15 **Detailed Description**

Fig. 1 is an illustration of the head of a user 10 wearing eyewear 11 in accordance with an embodiment of the present invention. The eyewear 11 may be conventional in appearance, having an eyewire 14, lens 18, and temple 15. As can be seen, the eyewear 11 in this embodiment has a micro-optical display 12 located on the lens 18 of the eyewear 11. The micro-optical display 12 in this embodiment is positioned to be within the field of view of the user's eye 17, so that, at the convenience of the user 10, the user 10 can look into the micro-optical display and view the information 13 displayed therein. By positioning the micro-optical display within the field of view of the user 10, the user 10 can access information from the display while participating in other activities.

The information 13 displayed to the user 10 may contain a variety of data including stock quotes, e-mails, driving directions, and other types of data.

The micro-optical display 12 may be integrated with or separately attached to the eyewear 11. The optics in the micro-optical display 12 may be designed to



project the image of one or more lines of characters out into space so that the characters appear in the field of view of the user.

Fig. 2.0 is a more detailed front perspective view of the eyewear from Fig. 1. As is evident, the eyewear 11 in this embodiment is configured such that it appears to be a conventional pair of eyeglasses. Alternatively, as will be discussed below, the eyewear 11 may also be configured as sport glasses, safety goggles, and any other type of eyewear that can be worn by a user.

The eyewear 11 in this embodiment is part of a versatile communication system. Working in conjunction with a Processor, Communication, Control, and Storage Unit (PCCSU shown in Fig. 2.2), the eyewear 11 is able to send and receive wireless calls over a wireless network. In addition, the eyewear 11 may also receive data from the wireless network and display that data on the micro-optical display. In use, a user of the eyewear 11 would converse with someone else over a wireless network using the microphone 20 and the speaker 24 mounted on the eyewear 11. The antenna 23 located on the eyewear may be used to communicate with the PCCSU or, alternatively, may be used to communicate directly over a wireless network.

As can be seen, the eyewear 11 in Fig. 2.0 contains a microphone 20, a micro-optical display 12, solar cells 22, an antenna 23, speakers 24, a transceiver 25, a microprocessor 26, a lens 29, a bridge 28, and a battery 27. These solar cells 22, located on the temple 15 of the eyewear 11, may be utilized to charge the battery 27 and may also be utilized to directly power the components of the eyewear 11. The microprocessor 26 is mounted in one of the ear rests of the eyewear 11. This microprocessor 26 may be in communication with each of the components and may be utilized to receive information from the transceiver 25 and then display it on the micro-optical display 12. The transceiver 25 may be used to perform transmitting and receiving functions for the eyewear 11. The transceiver 25 may be utilized to communicate with the PCCSU and may also be utilized to communicate directly over a wireless network. The lens 29 in this embodiment contains an opening or

notch allowing the micro-optical display 12 to traverse through the lens and extend beyond the outside face and the inside face.

Fig. 2.1 is a view of the viewing area of the micro-optical display 12 of Fig. 2.0. As can be seen, a row of alphanumeric characters is displayed by the micro-optical display 12 in this embodiment. This row of characters may be displayed by the micro-optical display 12 such that they appear to the user to be projected into space from 4 inches to infinity or at any comfortable distance to the user. While one line of characters is shown in Fig. 2.1, additional lines of characters may also be displayed in the micro-optical display 12. Examples of these additional lines of display, as well as the methods in which these various lines may be displayed, are discussed in more detail below.

Fig. 2.2 is a front perspective view of the Processor, Communication, Control, and Storage Unit (PCCSU) mentioned above. The PCCSU 220 may act as a communication link between a wireless network and the transceiver located in the eyewear. The PCCSU 220 may also act as a wireless telephone without utilizing the eyewear mentioned above. The PCCSU 220 may be the size of a belt pager and may be worn or somehow supported the user.

Fig. 2.2 reveals that the PCCSU 220 may have a microphone 221, a highspeed infrared data-link 223, a speaker 232, a display 231, a 3-D stack chip processor 230, an RF strip antenna 229, RF transceiver electronics 227, a fuel cell pack 226, nonvolatile memory 225, a recharge input plug 224, an on-off power switch 223, and display function keys 222.

Regarding these components of the PCCSU, the highspeed infrared data link 223 of the PCCSU 220 may be used for sending and receiving data to and from external data transfer units. The speaker 232 may be used for providing audible alarms, and all types of audio, speech, audio music, a combination thereof, and other types of information to the user. The display 231, which may be a liquid crystal display, may be used for providing the status of the PCCSU 220 as well as for providing other information to the user. The 3-D stack chip processor 230 contained within the PCCSU 220 may be used to carry out the processing functions of the

PCCSU 220. The 3-D stack microprocessor may also control the internal management functions of the PCCSU 220. These functions would include: the allocation of power to the displays, earphones, and microphones; data storage in memory; and, transmission and conversion of data between audio, video, electronic digital, and radio-frequency formats. The RF strip antenna 229 maybe used to communicate with the eyewear as well as to communicate over wireless networks. The VRA adjustments 228 are used for the separate adjustment of voice and of background audio so as to enhance a user's listening experience. The fuel cell pack 226 may be used to power the PCCSU 229. The nonvolatile memory 225 may be used to contain the necessary execution software as well as any other information that has been downloaded into the PCCSU 229. The recharge input plug 224 may be utilized to recharge the fuel cells with direct or alternating current and to provide the required power to operate the PCCSU 229 without the use of batteries. The fuel pack 226 may be bulk units stored in the PCCSU 229 or, alternatively, may be thin-film batteries applied to the surface of the PCCSU 229. The fuel pack 226 or any other means of providing power, may also be a separate unit, wearable by the user under the shirt collar, or the belt, or any other location of the body and connected to the PCCSU 229 and the eyewear by a direct conductive link. The display function keys 222 may be utilized to control the information that is displayed on the display 231 and on the micro-optical display of the eyewear. These display function keys can include: a stock quote key; a sports score key; a telephone book key; a time, temperature, or direction key; and a location or global position key. Lastly, the microphone 221 may be used to receive voice activation commands from the user rather than requiring tactile input from the user.

While the PCCSU is shown as a separate unit other configurations and embodiments are foreseeable. These other embodiments include electrically wiring or integrating the PCCSU functions into the eyewear. These other embodiments may also include eliminating the memory storage unit of the PCCSU and operating the PCCSU without a substantial amount of non-volatile storage. By removing the

memory storage unit the size and power consumption requirements of the PCCSU can be greatly reduced.

Alternatively, rather than having the transceiver, which performs the functions of a wireless telephone located in the PCCSU, the PCCSU may, instead, be connected to a wireless communication device that provides the requisite wireless communication functions. Moreover, in still other alternative embodiments the PCCSU may utilize the user's belt as an antenna and the PCCSU may be separable from the eyewear allowing the eyewear to communicate directly over a wireless network. Still further, while the command and control of the system may be through the use of a touch pad or buttons on the PCCSU, the PCCSU may also be commanded in a hands free manner through voice commands. The voice commands may be deciphered by voice recognition software incorporated into the PCCSU during its manufacture or alternatively the PCCSU may be "trained" to correlate certain user utterances with specific commands and functions. Artificial neural network co-processors could be also used to "train" the system to recognize the user's voice commands, thereby simplifying the software.

Fig. 2.3 is a front view of a user wearing an Integrated Communication System (ICS) in accord with an alternative embodiment of the present invention. In Fig. 2.3, the user 336 is shown wearing eyewear 332 and a PCCSU 330. As can be seen the eyewear 337 is supported by the user's head and is styled to look like a conventional pair of eyeglasses. The eyewear contains an eyewire 332, a temple 331, and a micro-optical display 333. The PCCSU 330 is shown supported by a strap 334, however, it could be supported by the user's belt or carried in the user's pocket purse or supported by any other means by the user, and, as discussed above, the PCCSU 330 may feed data to the eyewear 337 to be displayed on the micro-optical display 333. The PCCSU 330 feeds this data to the eyewear 337 via the wireless link indicated by arrow 338.

The ICS described above may provide various features and services to the user. By way of examples only, the micro-optical display may be configured to provide the local time, date, stock quote, gps, and schedule of the user, it may also

be configured to display telephone book information stored in the PCCSU, teleprompter information, voice mail, and pager messages. Moreover, a user who is hearing impaired may receive translations of the speech occurring around them in the micro-optical display much like the closed captioning systems employed on public broadcast television. Similarly, the ICS may provide a translation feature wherein the PCCSU would translate the conversation from an individual into a language that the user could understand. Once translated the conversation could then be displayed on the micro-optical display.

Fig. 3 is a comparative view of: a full VGA field of view 30; a quarter VGA field of view 32; and a micro-optical display field of view 31. As can be seen, the micro-optical display field of view 31 is smaller than both the full VGA field of view 30 and the quarter VGA field of view 32 in this embodiment. As noted above, an advantage of the micro-optical display is that the amount of power required to operate it is less than the amount of power required to drive a larger QVGA field of view 32 and a full VGA field of view 30. In addition, the data exchange requirements for displaying information on a micro-optical display may be less than the data exchange requirements for full VGA and QVGA displays.

The field of view shown in Fig. 3 replicates a 20-inch viewing distance from the user to a monitor. Using this scale, a 30 character wide micro-optical display field of view would be approximately 6.8 degrees in diameter. The display may also be other sizes such that the field of view available to the user may be greater or smaller.

Figs. 4.0 through 4.3 show various field of view configurations for the micro-optical display 12 of Fig. 1. As can be seen in Fig. 4.0, a single row of text, 30 characters wide, may be displayed in the micro-optical display. Alternatively, as is shown in Fig. 4.1, multiple rows of text, of various lengths, can be displayed in the micro-optical display or, as shown in Fig. 4.2, an image within a circular field of view may also be displayed in the micro-optical display. Moreover, as shown in Fig. 4.3, an image with a rectangular field of view may also be displayed within the

micro-optical display field of view. As is evident, the micro-optical display is a versatile display component providing various display options.

Figs. 5.0-5.3 are enlarged views of the various methods in which the micro-optical display can display alphanumeric characters. In Fig. 5.0 a first method is displayed wherein the first line of characters 512 remains stationary while the second line of characters 513 scrolls across the field of view of the user from right to left as indicated by the arrow 510. When the entire second line of characters 513 had scrolled across the display, the second line could move up as indicated by arrow 511 and displace the first line of characters 512. The stationary first line of characters 512 could then contain the first 30 characters of the second line of characters 513 and the second line of characters 513 could then display the next line of text in the scrolling fashion discussed above. While a defined string of 30 characters is illustrated in this embodiment the number of characters in each line may be increased or decreased to a number suitable to the user -- a 15-45 character range believed to be the optimum character display length for the micro-optical display.

Alternatively, as can be seen in Fig. 5.1, a single line of characters 514 can be utilized to display the entire message. In Fig. 5.1 the single line of characters 514 would move from right to left and would contain the entire message. The rate of scroll of these characters can be controlled remotely by an adjustment on the PCCSU or on the user's glasses. This continually scrolling format can be useful for displaying real-time data such as stock quotes and other similar real-time information streams.

Similarly, as can be seen in Fig. 5.2, in circumstances where the lines of characters are less than the display length of the micro-optical display, the characters would not need to scroll across the screen but, rather, would simply be displayed in the row and would be displaced by the next row of characters. In Fig. 5.2 the first line of characters is noted at 532 and the second line of characters is noted at line 533.

Fig. 5.3 illustrates another alternative embodiment. In this embodiment, a three-line display 585 is illustrated. The bottom line 581 scrolls from right to left for the user as indicated by arrow 570. Then, when all the data to be scrolled on the bottom line has been displayed, the bottom line 581 displaces the middle line 582, which in turn displaces the top line 583. In other words, the bottom line 581 would be scrolling from right to left in the field of vision of the user while the middle line 582 and the top line 583 would be scrolling up the field of vision of the user.

In each of these various alternative embodiments the rate of scroll of the data across the display and the rate of scroll up and down the display may be adjusted and controlled by the user through controls located on the eyewear. The user's preferential settings may then be stored by the eyewear or the PCCSU for later retrieval and use. Moreover, not only can these settings be stored for a single user but the settings may also be stored for several users who may choose their predetermined preferences when they utilize the present invention.

The micro-optical display may also display text in any language, and may scroll from right to left, left to right or vertically as required by the displayed language. Moreover, some languages allow either left to right or right to left reading (e.g. Chinese characters may be written in either direction), in these cases the user may select the preferred direction of scrolling.

The character size of the characters displayed on the micro-optical display may also be adjusted in accordance with another alternative embodiment of the present invention. In this alternative embodiment rather than displaying the characters on a single display line the characters are displayed across several display lines such that fewer individual characters may be displayed at one time but that those characters that are displayed may be two or three times as large as the regularly sized characters. Like the other preferential settings discussed above the user of this alternative embodiment may select this display option as one of her preferential settings.

Furthermore, the display may also be adjusted to allow the speed of the scrolling text to correspond with the speed and pauses of the coinciding input. In

other words, in another alternative embodiment the microprocessor controlling the information displayed on the micro-optical display can modulate the display information to coincide with the natural pauses of the audible speech being displayed on the micro-optical display.

5           These various display options allow the display to provide the information in the most comfortable and easily comprehensible manner to the user.

Fig. 6 is a perspective front view of an alternative embodiment of the present invention. As can be seen in Fig. 6, a micro-optical display 62 is mounted on a lens 691 positioned within the eyewire 69 of the eyewear 693. In addition, a battery 61, a  
10 microprocessor 60, a miniature transmitter-receiver 67, a speaker 66, and an antenna 65 are all located on the temple 692 of the eyewear 693. A directional microphone 64 is also mounted on the eyewire 69 of the eyewear 693.

The micro-optical display 62 in this alternative embodiment may be placed in the field of vision of either eye of a user or, alternatively, as will be discussed  
15 below, can be placed in the field of vision of both of the user's eyes. In so doing, a user can be provided information in a reference mode when information is provided to one eye, or in a three-dimensional mode when information is provided to both eyes.

Due to the extremely small diameter 63 of the micro-optical display 62  
20 (6mm in this embodiment), the micro-optical display 62 should be properly aligned within the field of vision of the user's various angles of gaze. Similarly, when using two micro-optical displays, as is illustrated below, the inter-pupillary distance of the user (the distance between the pupils of the user's eyes) must be taken into account in order to properly position the micro-optical displays 62 in the user's line of sight.  
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Fig. 7 is a front perspective view of another alternative embodiment of the present invention. As can be seen a memory storage unit 79 has also been placed on the temple of the eyewear 70 of Fig. 7, and a remote wire 78 is shown connecting the micro-optical display 74 to the miniature transmitter receiver 77. Also illustrated



in Fig. 7 are the microphone 76, the battery 71, the microprocessor 73, and the antenna 75.

Fig. 8 illustrates a front perspective view of the eyewear 840 in accordance with another alternative embodiment of the present invention. In this embodiment, the microphone previously shown coupled to the eyewire in Fig. 7 is now extendable such that it may be positioned more closely to a user's mouth. As can be seen in Fig. 8, the microphone 815 may be positioned on an extension 820 which may be coupled to the eyewire 825. Buttons 810 are located on the transceiver 830 which is located on the temple 835 of the eyewear 840. In use, and as required by the user, the user would push the buttons 810 to extend or retract the microphone 815 to become closer to or further away from their mouth.

Fig. 9 is a side view of the embodiment shown in Fig. 8. As can be seen, the extended microphone 815 is attached to an extension 820 which is attached to the eyewire 825. Also visible in Fig. 9 are the ear 920 of the user, the eye 925 of the user, and buttons 810 for controlling the movement of the microphone 815.

Alternatively, the microphone, instead of being coupled to the eyewire, may also be placed on various other locations of the eyewear. For example, in Fig. 10, the microphone 1000 is positioned on the temple 1010.

Fig. 11 is an enlarged perspective view of a micro-optical display 1100 in accordance with an alternative embodiment of the present invention. The front of the micro-optical display is clearly illustrated, along with the back, the soft skin, the micro-character display, the third optical element, the markings, the diameter, and the length. The diameter and length may vary according to the individual application of the micro-optical display. In the embodiment illustrated in Fig. 11 the length is 7mm and the diameter is 6 mm.

The third optical element 1120 in this embodiment may be a lens which can be used to correct astigmatisms or other visual impairments of a user.

Consequently, in use, a user looking into the front of the micro-optical display would not need the additional assistance of the corrective lenses of their

eyewear as the image displayed by the micro-optical display 1100 would correct many visual impairments of the user. The markings 1180, which are also clearly evident in Fig. 10, are used to correct the user's astigmatic axis. The manner in which these markings 1180 are used is discussed in more detail below.

5           Fig. 12 is a perspective view of a collapsible safety cage structure 1210 that acts as a structural support for the micro-optical display 1100 of Fig. 11. The collapsible safety cage structure 1210 may be made from metal, plastic or some other rigid material. In Fig. 12, the safety cage structure 1210, has a back 1140, a front 1130, rigid rings 1240, and support members 1230. The support members  
10   1230 contain angle notches 1200.

          As the micro-optical display can be located at various positions on the user's eyewear and, consequently, at various positions near the user's eye, the collapsible safety cage structure 1210 reduces the risk of injury to the user. As can be seen, collapsible angles 1200 are positioned throughout the support members 1230. These  
15   angles 1200 provide points of increased stress which can fail during axial impact. When axial compressive forces are placed on the collapsible safety cage structure 1210 the support members 1230 can fold or otherwise deform at these notches 1200. This tendency to collapse under axial loads reduces the amount of energy that can be transmitted through the structure 1210 to a user's eye as some of the energy from an  
20   impact would be dissipated during the deformation and collapse of the safety cage structure 1210. In use, if the micro-optical display was forced towards a user's eye, the rib cage structure 1210 would compress, acting as a cushion, thereby reducing or possibly eliminating the transfer of damaging impact forces to the user's eye. In certain embodiments, the safety cage structure may be made of materials that  
25   elastically deform during impact.

          Fig. 13 is a perspective view of the collapsible safety cage structure 1210 of Fig. 12 shown containing additional elements. In Fig. 13, a micro-character display 1300 is mounted near the perimeter of the safety cage structure 1210. This micro-character display 1300 generates the image that will ultimately be viewed by the  
30   user. The micro-character display differs from conventional displays as it does not

need to recreate the numerous resolution lines associated with conventional scanning displays. The micro-character display in this embodiment may be a Light Emitting Diode (LED) display, a transparent Liquid Crystal Display (LCD) or any other character generator.

5           The micro-character display 1300 of the embodiment in Fig. 13 is shown in optical communication with a first optical element 1320, a second optical element 1310, and a third optical element 1120. In this particular embodiment, the first optical element 1320 is an elliptical mirror 2mm x 3mm, the second optical element 1310 is a concave aspheric mirror having a radius of 20mm and the third optical  
10   element 1120 is an astigmatism-correcting lens. These three optical elements reflect, focus, and manipulate the image generated by the micro-character display 1300 to provide an enlarged and mostly focused view of the image generated by the micro-optical display 1300 for the user.

          Presbyopic correction is designed into the micro-optical display device by  
15   collimating the rays of light to infinity. A simple adjustment of the back mirror 1310 location corrects sphere power required for hyperopes and myopes.

          The above-noted optical elements may be made of plastic, glass, metal, ceramic or other appropriate materials which will permit them to reflect or focus light as required in their particular application. The skin of the micro-optical device  
20   may be made of plastic, rubber, fabric, or some other flexible material, and the cage may be made of metal, ceramic or other rigid material. For best image contrast, the micro-optical display skin should be opaque or reflective to external light, while the interior surface of the skin should be dark or black such that it will absorb errant or stray light.

25           Fig. 14 is a side view of a micro-optical display 1490 in accordance with another alternative embodiment of the present invention. The micro-optical display 1490 in Fig. 14 contains a micro-character display 1440 which itself contains an LCD array 1430. The LCD array 1430 in this embodiment is rectangular in shape and 60 by 800 microns in size although it may be other sizes. The pixel spacing for

the LCD array 1430 may be between 10 and 12 microns in this embodiment.

Therefore, the LCD array 1430 may be placed within a 1.5 mm by 1.5 mm space.

The micro-optical display 1490 also contains a first optical element 1420, which may be a flat elliptical mirror having ellipses diameters of 2 mm and 3 mm, and a second optical element 1480, which may be a concave mirror with a radius of 20 mm and a diameter of 5 mm. In this exemplary embodiment, the micro-optical display 1490 has a diameter 1410 of 6.0 mm and a length 1470 of 7.0 mm. The length 1450 of the micro-character display 1440 in this embodiment is 1.5 mm.

The LCD array 1430 utilizes ambient light to illuminate the image that will be displayed for the user. By using ambient light the amount of power required to drive the display can be reduced. The micro optical display device in this embodiment does not utilize a beam splitter thereby maximizing available illumination and thereby allowing for the use of only ambient illumination.

The dimensions of the micro-optical display may be modified in various other embodiments. For example, for micro-character displays employing 10 micron pixel spacing and having up to three rows of characters, each 30 characters in length, wherein mirrors are used as the optical elements within the micro-optical display, the length of the micro-optical display may be 7.0 mm and the diameter may be 6.0 mm. By comparison, in lens based designs, where focusing and enlarging lenses are utilized as optical elements within the micro-optical display the micro-optical display height may be reduced to 4.5 mm and the diameter may be reduced to 4.0 mm. Similarly, if prisms and lenses were employed as the optical elements the length of the micro-optical display may be reduced to 4.5 mm and the diameter of the micro-optical display may be reduced to 4.0 mm. In addition, while a micro-character display 1440 is discussed above, it is worthy of note that, if desired by the user, the light guides may be adapted to accommodate a larger micro-character display.

The LCD display 1430 may be made from transmissive LCD's and reflective LCD's. When reflective LCD's are utilized supplemental illumination may be required. For displays employing up to three rows of 30 characters each, the pixel to

pixel spacing may be reduced to 5 microns, the length of the micro-optical display maybe 4.5 mm, the diameter of the micro-optical display may be 4.0 mm and the power consumption may be reduced to 10mW. For similarly sized micro-character displays utilizing illuminated transmissive LCD's the size and power consumption  
5 would be similar wherein the pixel to pixel spacing would be 10 microns. Comparatively, for similarly sized micro-character displays utilizing ambient lighting, the power consumption and the pixel to pixel spacing would be similar but the micro-optical display would be larger in length and in diameter.

The LCD may also be made from emetic LCDs and ferro-electric LCDs.  
10 Ferro-electric LCDs are advantageous because they allow for closer pixel spacing per unit area which results in a higher image resolution.

Fig. 15.0 is an enlarged view of a micro-optical display 1515 in accordance with another alternative embodiment of the present invention. As can be seen in Fig. 15.0, micro-optical display 1515 is coupled to the rear concave surface closest  
15 to the lens 1514 closest to the user's eye and is in the direct line of vision of the eye 1512 of the user. The micro-optical display 1515 is marked with an astigmatic axis 1511 connecting two axis markings 1513. In this particular embodiment, this astigmatic axis 1511 may be set to correct a user's astigmatic lens axis. It should be further identified that the proper astigmatic powered lens is provided by way of lens  
20 customization and the astigmatic axis 1511 is set for the user's needs. Also, the user's sphere power is provided by way of adjusting the distance between the optical elements incorporated in the micro-optical display 1515. Furthermore, some or all of the sphere power could be incorporated with the lens which provides the astigmatic power.

25 Fig. 15.1 is an enlarged view of the axis markings 1513 of Fig. 15.0. As can be seen, they are marked with different degrees ranging from 0 to 180 and are marked around the entire circumference of the micro-optical display 1515. Regarding the astigmatic correction provided by the micro-optical display, a sag of 1 diopter cylinder power over the 6.0 mm diameter is 0.009 mm or 9 microns.

Consequently, for a 10 diopter cylinder, the sag thickness would be 0.090 mm or 90 microns.

Fig. 16.0 is an enlarged view of a micro-optical display 1640 positioned near an eye 1612 of a user in accordance with an alternative embodiment of the present invention. As can be seen, the astigmatic corrector lens 1610 (a refractive or diffractive lens) having the proper astigmatic axis setting 1615, is aligned with the eye 1612 of a user and diopter markings 1630 are present on the side of the micro-optical display 1640 having a micro-character display 1660 attached. While a lens is used to correct for the astigmatism of the user in this embodiment, any optical element may be used to correct for the astigmatism.

Fig. 16.1 is a sphere power chart providing the mirror adjustment in millimeters for various sphere diopter settings. As can be seen, mirror adjustment ranges from 0 mm to 1 mm as the diopters of sphere power increases from 0 to 10 diopters. The information provided in this chart is calculated based upon one embodiment wherein a micro-optical display has a 6-mm diameter and a 7-mm length. This mirror adjustment 165 allows for customized correction of the user's spherical correction. Therefore, the proper combination of the astigmatic correction lens 1610, the astigmatic axis setting 1615, and the sphere power adjustment 1650 will allow the user to see the image of the micro-character display 1660 clearly.

Fig. 17 is another alternative embodiment of the present invention. As can be seen, the micro-character display 1700 is positioned on top of the micro-optical display 1720. Alternatively, the micro-character display 1700 could be positioned in numerous other positions on or within the micro-optical display 1720 as required by the individual application.

Fig. 18.0 is another alternative embodiment of the present invention wherein the micro-character display 1810 is illustrated with the optional illumination system 1800. In this embodiment, as discussed above, rather than using ambient light to illuminate the micro-character display 1810, the optional illumination system 1800 provides additional light to illuminate the micro-character display. In so doing, the micro-optical display may be used in various light situations ranging from a

complete lack of light whereby additional light is utilized from light source 1800 to low level, moderate or bright ambient light.

Figs. 18.1-18.8 provide various positions and configurations of the micro-optical display in accordance with other alternative embodiments of the present invention. As can be seen in Fig. 18.1, the micro-optical display does not need to be in direct axial alignment with the eye of the user. Comparatively, as can be seen in Fig. 18.2, the micro-optical display may be in direct axial alignment with the eye of the user. Thus, in order to accommodate the various relative locations between the user's eye and the micro-optical display, the micro-optical display may contain or be in optical communication with various optical elements. Some of these various configurations are illustrated in Figs. 18.3-18.8.

In Fig. 18.3, three different optical elements are used, a prism 1830, a curved mirror 1832, and a flat mirror 1831. These three optical elements manipulate and enlarge an image generated by the micro-character display 1834 such that the image may be readily viewed by the user.

Similarly, in Fig. 18.4, the large mirror 1840 is tilted to direct the display image of the micro-optical display toward a user's eye, which is not shown. In Fig. 18.5 both mirrors, 1840 and 1870, are tilted in order to align the display of the micro-optical display. In Fig. 18.6, a large mirror 1860 is utilized to guide the alignment of the display image towards the user's eye. In Fig. 18.7, a flat alignment mirror 1870 is used to align the display and in Fig. 18.8, a focus element 1880 is used to align the display with the user's eye. As is evident, then, these and numerous other configurations of optical elements, both within and outside of the micro-optical display, may be used in accordance with various embodiments of the present invention.

Figs. 19 and 20 are front perspective views of alternative embodiments of the present invention. Rather than utilizing the light source coupled directly to the micro-character display as described in the above embodiments, the embodiment viewed in Fig. 19 uses a light source 1910 coupled to the eyewire 1915 of the eyewear 1920 to illuminate the micro-optical display 1912. As can be seen, in order

to accomplish this, a fiber optic line 1911 may connect the light source 1910 with the micro-optical display.

In Fig. 20, an alternative embodiment of Fig. 19, the micro-optical display 2022 may be coupled to the eyewire 2023 as opposed to being suspended in the lens as in Fig. 19. The light source 2020 is coupled to the eyewire 2023 and sends light to illuminate the micro-character display resident in the micro-optical display 2022 along fiber optic line 2021. In this preferred embodiment the lens maybe notched or grooved to create an opening that accepts the micro-optical display.

Fig. 20.1 is an enlarged view of an eyewire 2011 and a micro-optical display 2012 in accordance with a preferred alternative embodiment. As can be seen in this embodiment the micro-optical display 2012 may be coupled to the eyewire 2011 and may be supported by it. In this embodiment a spectacle lens (not shown) would be placed into the eyewire 2011 around the micro-optical display. By mounting the micro-optical display 2012 directly to the eyewire 2011 a spectacle lens can be interchangeably mounted to the eyewire. In other words, a user can have a prescription spectacle lens inserted into the eyewire 2011 and then, later, should their prescription change, the original spectacle lens can be readily removed and the new spectacle lens can be placed within the eyewire 2011. As previously noted, the corrective lens power of the micro-optical display can be independent of the spectacle lens.

Fig. 20.2 is a front view of a spectacle lens 2024 that has been notched to fit around a micro-optical display (not shown).

Fig. 21 is a side view of another alternative embodiment of the present invention. As can be seen in Fig. 21, a micro-processor 2170 and battery 2160 are coupled to a temple 2115 of eyewear 2100. The micro-optical display 2140, in Fig. 21, has a micro-character display 2130 coupled to it. In addition, the micro-optical display 2140 is positioned within the spectacle lens 2110. In this embodiment, the micro-optical display 2140 protrudes from both the rear surface 2181 and the front surface 2182 of the spectacle lens 2110.



Fig. 22 is a side view of another alternative embodiment of the present invention wherein the micro-optical display 2211 is mounted completely on the inside face of the spectacle lens 2210. As can be seen, the micro-optical display device 2211 is coupled to a pivot ball 2212 that is coupled to a mounting pad 2213.

5 This pivot ball 2212 acts as a ball joint for the micro-optical display 2211 and allows the micro-optical display 2211 to be positioned in various positions of alignment relative to the eye 2214 of the user. The micro-optical display 2211 is in communication with the mounting pad 2213 which has two mounting pins 2216. These mounting pins 2216 releasably anchor the mounting pad 2213 to the lens and  
10 also provide the necessary signal and power connections for the micro-optical display 2211. Consequently, as required by the user, the micro-optical display 2211 may be relocated to other positions on the lens by unplugging the mounting pad 2213 and re-plugging it into pin openings at a different location on the face of the spectacle lens 2210.

15 Fig. 23 is the inside view of eyewear in accordance with another alternative embodiment of the present invention. As can be seen, a sliding track 2320 is present in the eyewires 2310 of the eyewear 2350. The sliding track 2320 provides a guide for the micro-optical display 2330 to slide back and forth within. By providing the sliding track 2320 for the micro-optical display 2330, a user can more  
20 comfortably align and position the micro-optical display 2330 for their viewing.

Fig. 24 is a front perspective view of another alternative embodiment of the present invention. Two micro-optical displays 2410 are utilized in this embodiment. As mentioned earlier, by providing two micro-optical displays three dimensional images may be projected into the field of view of the user. These two micro-optical  
25 displays 2410 may be rigidly connected to extenders 2400 and the extenders 2400 may be coupled to the temples 2440 of the eyewear 2420. Buttons 2430 may be integral parts of the transceiver 2460 which can be coupled to the temple 2440 of the eyewear 2420. These buttons 2430 may be used to control the movement of the extenders 2400 and, consequently, the position of the micro-optical display 2410  
30 between the lens and the user's eye.

Fig. 25.0 is a side view of the embodiment illustrated in Fig. 24. The connection of the extenders 2400 to the temple 2440 is clearly seen in this view. In Fig. 25.0 the extender 2400 is coupled to the temple 2440 of the eyewear and the micro-optical display 2410 is suspended in rear of the spectacle lens 2500 closest to the eye 2501. Alternatively, while the micro-optical display 2410 is shown between the spectacle lens 2500 and the user, it may also be placed in front of the lens such that the viewer would view the micro-optical display 2500 through the eyewear spectacle lens 2500. If the user were to view the micro-optical display 2410 through the spectacle lens 2500 the micro-optical display would not need to correct the refractor error of the user. Comparatively, and as discussed above, if the user were to directly view the images in the micro-optical display 2410 the micro-optical display 2410 would need to correct for the vision impairments of the user. Therefore, if the micro-optical display is located behind the lens or adjacent to the lens whereby the spectacle lens is not looked through by the user prior to looking into the micro-optical display the user's refractive error needs to be corrected by the micro-optical display.

Fig. 25.1 is another alternative embodiment of the present invention. In this embodiment rather than utilizing the micro-optical display discussed above, a display 2510, containing organic light emitting diodes, is coupled to the outside surface 2515 of the spectacle lens 2511. This display 2510 is in optical communication with a lens 2512 located on the inside surface 2516 of the lens 2511. This lens 2512 may contain an electro-active layer 2513. An advantage of utilizing the organic light emitting diodes in this embodiment is that the display may be transparent until it is activated.

As noted, the display 2510 in Fig. 25.1 is fixed to the outside surface 2515 of the lens 2511. This may be accomplished by attaching the display 2510 through a variety of available bonding techniques known to those of skill in the art. This electro-active diffractive layer 2513, which is located on the inside surface 2516 of the lens 2511, may be approximately the same size as or larger than the display 2510. The display 2510 consists of a conventional fixed focal length lens 2512 in

contact with a diffractive layer 2513 which, when activated through an applied voltage, works in combination with the lens 2512 to magnify and project the image into the field of view of the user.

Fig. 26 is a rear view of eyewear 2630 in accordance with yet another alternative embodiment of the present invention. In this embodiment, light detectors 2610 are placed on the user's side of the eyewires 2620 along with light sources 2600. These light sources 2600 and light detectors 2610 work in tandem to provide various services to the wearer of the eyewear 2630.

In use, the light source 2600, which is aimed at the user's eye, is activated. Light reflected by the user's eye from the light source 2600 will then be detected by the detectors 2610. When the user's eye is closed the amount of light reflected back to the detectors 2610 will be different from when the user's eye is opened. Utilizing this information the eyewear can determine when the user's eyes are opened and closed. This information is then compared to stored conventional information in the eyewear's microprocessor. Such information allows for normal blinking but may not allow for lid closure which could be a precursor to sleep. One foreseeable application of this apparatus would be to utilize it when a user is driving. Should a user fall asleep while driving, the eyewear's microprocessor in this embodiment could initiate an audible alarm or could alternatively flash an intense light using light sources 2600 to awaken the user.

Fig. 27 provides a view of another alternative embodiment of the present invention. As can be seen in Fig. 27, eyewear 2795, which resembles sports goggles, may also be employed in the present invention. In Fig. 27 the eyewear 2795 contains: a speaker 2770, a battery strip 2730, a camera 2780, a microphone 2790, a micro-optical display 2700, an expandable/retractable arm 2785, and a motor 2710.

Fig. 28 illustrates an emergency response system in accordance with another alternative embodiment of the present invention. As can be seen, the PCCSU 2830 in this alternative embodiments is in wireless communication (as depicted by arrow 2870) with the remote wireless sensor 2810 located on the body of a user 2800. The

PCCSU 2830 is also in wireless communication with 911 emergency services 2840 (as depicted with arrow 2860) and with the eyewear 2850 (as depicted by arrow 2860). In use, should the remote wireless sensor 2810 sense that a user is having heart troubles or perhaps has fallen, the PCCSU 2830 would detect an appropriate  
5 signal and would then take appropriate steps to resolve the situation.

If the PCCSU 2830 detected that the user 2800 had fallen, the PCCSU 2830 would determine if the user was still conscious by sounding an audible signal or by flashing some lights in the eyewear 2820. If no response was detected, the PCCSU would contact emergency services 2840. Similarly, if the PCCSU 2830 were to  
10 receive a signal alerting it of a heart attack in the user the PCCSU 2830 would immediately contact emergency services 2840 via a wireless network. In so doing, a wearer would have access to emergency services, such as 911, even if she had become unconscious or had fallen and were otherwise unable to contact the emergency services. The PCCSU 2830 in this medical embodiment may possess  
15 GPS capabilities and notify 911 of the exact location of the user.

Fig. 29 is a front perspective view of a charging data link unit 2930 in accordance with another alternative embodiment of the present invention. In Fig. 29, a charging unit 2930 having a highspeed infrared data link 2950 is shown charging the PCCSU 2910, the eyewear 2940, and the additional earpieces 2960,  
20 which contain additional batteries. When a user needs to charge the batteries in the eyewear or, alternatively, to download data to the PCCSU or the eyewear, the user would place the eyewear 2940 and the PCCSU 2910 into the charging data link unit 2930. Then, as required, the battery located either in the complete eyewear or just the spare temple would be changed, further, the appropriate data could be transferred  
25 to the PCCSU and the eyewear through the highspeed data link 2950.

Numerous other embodiments of the present invention are also plausible. For example, the light sources in the eyewear may be utilized to silently signal the arrival and urgency of an incoming message. This alert may then be received either visually through the micro-optical display, or audibly through speakers or  
30 earphones. Similarly, various sensors may be incorporated into the ICS for

providing navigational or other real-time functions. For example, a user would be able to discern their position using Global Positioning System. Moreover, the ICS could interact with the automobile of the user so that directions, the speed of the vehicle or other vehicle warning lights, could be displayed by the micro-optical display.

In addition, rather than utilizing the ICS to find the User's global position, the ICS may also be utilized to find the user's position in smaller areas as well. For example, prior to entering a commercial store, a list of items to be purchased may be inputted into the PCCSU's memory. Then, upon entering the store, the PCCSU would begin to communicate with a device, located in or at the commercial store, which can communicate with the PCCSU. By way of this interactive communication between the PCCSU and the store's device the user will be guided through the store, up and down the aisles or through the departments in the most efficient manner. Furthermore, as the user approaches each item on the list, the user will be alerted to their proximity to the item by a signal to collect the item.

In still other alternative embodiment an earphone aid, which attaches to the user's ear is utilized to assist the user in hearing audible information. Furthermore, a video camera may be integrated or coupled to the eyewear providing for video and or still images to be taken. These images would then be transmitted to the PCCSU and then re-transmitted over a wireless network. The camera in this embodiment may be placed in any location within or on the eyewear.

While manual controls have been described above, the various embodiments of the present invention may also be controlled through voice commands or through other interactive commands. For example, the light detectors can be utilized to detect a series of blinks which can then control the various aspects of the present invention. This could include controlling the micro-optical display and the PCCSU. Similarly, portions of the eyewear or the PCCSU may be powered down to conserve energy when the particular functions are not needed. Moreover, while each of the above embodiments have contained eyewear containing a full spectacle lens, the eyewear embodied in the present invention is not so limited as the eyewear may also

include multi-focal lenses, half-eye frames, minimal frames without lenses, and any other configuration wherein the eyewear can be mounted to the face of the user such that a micro-optical display can be positioned in the viewing range of the user.

In still another embodiment, the lenses contained within the eyewear may be  
5 electro-active powered lenses which may change power and or tint electro-actively.  
In this alternative embodiment the user is able to actuate changes of the lenses' power or color through voice commands or manual switching.

Thus the present invention provides for a versatile Integrated  
Communication System. The above disclosed embodiments are illustrative of the  
10 various ways in which the present invention maybe practiced. Other embodiments can be implemented by those skilled in the art without departing from the spirit and scope of the present invention.

**What Is Claimed Is:**

1. A head-mounted viewable display system for a user comprising:  
eyewear; and,  
5 a micro-optical display connected to said eyewear,  
said micro-optical display positioned in the field of vision of the user,  
said micro-optical display configured to correct a portion of the  
refractive error of the user.
- 10 2. The eyewear of claim 1 wherein a portion of the refractive error of the user  
that said micro-optical display is configured to correct includes an astigmatism of  
the user.
3. The eyewear of claim 1 wherein a portion of the refractive error of the user  
15 that said micro-optical display is configured to correct includes myopia.
4. The eyewear of claim 1 wherein a portion of the refractive error of the user  
that said micro-optical display is configured to correct includes hyperopia.
- 20 5. The eyewear of claim 1 wherein a portion of the refractive error of the user  
that said micro-optical display is configured to correct includes presbyopia.
6. The eyewear of claim 1 wherein said eyewear includes an eyewire.
- 25 7. The eyewear of claim 6 wherein said micro-optical display is supported by  
said eyewire.
8. The eyewear of claim 6 wherein said micro-optical display is slidably  
coupled to said eyewire.  
30

9. The eyewear of claim 6 wherein said micro-optical display is pivotally coupled to said eyewire.
- 5 10. The eyewear of claim 6 wherein said eyewear also includes a lens supported by said eyewire.
11. The eyewear of claim 10 wherein said micro-optical display is located in a notch in said lens.
- 10 12. The eyewear of claim 10 wherein said micro-optical display is mounted on said lens.
13. The eyewear of claim 10 wherein said micro-optical display contains a first  
15 optical element that is elliptically shaped.
14. The eyewear of claim 10 wherein said micro-optical display contains a second optical element that is a concave mirror.
- 20 15. The eyewear of claim 14 further comprising a prism in optical communication with said second optical element.
16. Eyewear supported by the head of a user comprising:  
a micro-optical display coupled to the eyewear,  
25 said micro-optical display containing a micro-character display,  
said micro-character display configured to display a first line of characters.
17. The eyewear of claim 16 further comprising:



a micro-processor coupled to the eyewear in communication with  
said micro-optical display;

a wireless receiver coupled to the eyewear, said wireless receiver in  
communication with said micro-processor display; and,

5 a wireless transmitter coupled to the eyewear,  
said wireless transmitter in communication with said micro-  
processor.

18. The eyewear of claim 16 wherein said micro-optical display is further  
10 configured to correct a portion of the refractive error of the user.

19. The eyewear of claim 16 wherein said micro-optical display is moveably  
coupled to the eyewear.

15 20. The eyewear of claim 16 wherein said micro-optical display is slidably  
coupled to the eyewear.

21. The eyewear of claim 16 wherein said micro-optical display is pivotally  
coupled to the eyewear.

20 22. The eyewear of claim 16 wherein the eyewear contains a lens, said lens  
containing a notch wherein said micro-optical display is located.

23. The eyewear of claim 16 wherein said micro-optical display is mounted on  
25 the lens.

24. The eyewear of claim 16 wherein said micro-character display is adapted to  
utilize ambient light to illuminate characters displayed on said micro-character  
display.

30

25. The eyewear of claim 16 further comprising a supplemental light source in optical communication with said micro-character display.

26. Eyewear for a user comprising:

5                   a micro-optical display coupled to the eyewear,  
                  said micro-optical display containing a micro-character display,  
                  said micro-character display configured to display a first row of  
characters and a second row of characters, the first row of characters scrolling across  
the field of vision of the user and the second row of characters being stationary in  
10 the field of vision of the user.

27. Eyewear having an eyewire and a lens comprising:

                  a micro-optical display supported by the eyewear;  
                  a micro-character display coupled to said micro-optical display, said  
15 micro-character display configured to display a first line of characters;  
                  a first optical element located within said micro-optical display  
positioned a predetermined distance from said micro-character display; and  
                  a second optical element located within said micro-optical display  
positioned a predetermined distance from said first optical element.

20

28. The eyewear of claim 27 wherein said micro-optical display is supported by the eyewire.

29. The eyewear of claim 27 wherein said micro-optical display is slidably  
25 coupled to the eyewire.

30. The eyewear of claim 27 wherein said micro-optical display is pivotally coupled to the eyewire.

31. The eyewear of claim 27 wherein said second optical element is slidably mounted within said micro-optical display.
32. The eyewear of claim 27 wherein said micro-optical display is located in a notch in the lens.
33. The eyewear of claim 27 wherein said micro-optical display is mounted on the lens.
34. The eyewear of claim 27 wherein said first optical element is elliptically shaped.
35. The eyewear of claim 27 wherein said second optical element is a concave mirror.
36. The eyewear of claim 27 further comprising a prism in optical communication with said second optical element.
37. The eyewear of claim 27 wherein said micro-character display is adapted to utilize ambient light to illuminate characters displayed on said micro-character display.
38. The eyewear of claim 27 further comprising a supplemental light source in optical communication with said micro-character display.
39. Eyewear having an eyewire and a lens comprising:  
a micro-optical display supported by the eyewear; and  
a micro-character display coupled to said micro-optical display,  
said micro-character display configured to display a line of characters;

said micro-optical display further configured to adjust the focus of said micro-character display to correct for a portion of the visual needs of a user.

40. The eyewear of claim 39 wherein said micro-character display is further  
5 configured to scroll the first line of characters displayed on said display across said display.

41 The eyewear of claim 39 wherein said micro-optical display is supported by  
the eyewire.

10

42. The eyewear of claim 39 wherein said micro-optical display is slidably  
coupled to the eyewire.

43. The eyewear of claim 39 wherein said micro-optical display is pivotally  
15 coupled to the eyewire.

44. The eyewear of claim 39 wherein said second optical element is slidably  
mounted within said micro-optical display.

20 45. The eyewear of claim 39 wherein said micro-optical display is located in a notch in the lens.

46. The eyewear of claim 39 wherein said micro-optical display is mounted on  
the lens.

25

47. The eyewear of claim 39 wherein said first optical element is elliptically  
shaped.

48. The eyewear of claim 39 wherein said second optical element is a concave  
30 mirror.

49. The eyewear of claim 39 further comprising a prism in optical communication with said second optical element.
50. The eyewear of claim 39 wherein said micro-character display is adapted to  
5 utilize ambient light to illuminate characters displayed on said micro-character display.
51. The eyewear of claim 39 further comprising a supplemental light source in optical communication with said micro-character display.
- 10 52. Eyewear, worn by a user having an eye, comprising:  
a light source mounted to the eyewear;  
a light detector mounted to the eyewear; and  
a micro-processor in communication with said light detector,  
15 said micro-processor adapted to analyze the amount of light from said light source reflected back from the user's eye received by said light detector to determine if the user's eye is opened or closed and, when the user's eye is closed for a predetermined amount of time, said micro-processor further adapted to generate a signal to trigger an alarm.
- 20 53. The eyewear of claim 52 wherein said signal triggers an audible alarm.
54. The eyewear of claim 52 wherein said signal triggers a visible alarm.
- 25 55. An eyewear system having an eyewire and a lens comprising:  
a micro-optical display mounted to the eyewear,  
said micro-optical display having a collapsible safety cage.
56. The eyewear system of claim 55 wherein said micro-optical display is  
30 mounted to the eyewire.

57. The eyewear system of claim 55 wherein said micro-optical display is mounted to the lens.

58. The eyewear system of claim 55 wherein said micro-optical display contains  
5 a liquid crystal display configured to display a row of alphanumeric characters.

59. The eyewear system of claim 55 further comprising:  
a microphone mounted on the eyewear;  
a first microprocessor mounted on the eyewear in communication  
10 with said micro-optical display; and,  
a power source coupled to said micro-optical display and said first microprocessor and configured to provide power to said micro-optical display and said first microprocessor.

15 60. The eyewear system of claim 59 further comprising:  
a wearable unit supported by the body of a user;  
a second microprocessor located within said wearable unit, said second microprocessor in wireless communication with said first microprocessor;  
and  
20 a storage system located within said wearable unit in communication with said second microprocessor.

61. The eyewear system of claim 59 further comprising:  
a reflected light sensor mounted to the eyewire.

62. An integrated communication system comprising:  
a head-mounted frame;  
a speaker mounted to said frame;  
a lens mounted to said frame;  
5 a micro-optical display supported by said frame, said micro-optical display having a micro-character display;  
a first microprocessor supported by said head mounted frame in communication with said micro-optical display;  
a storage device in communication with said first microprocessor;  
10 and  
a wireless communication device in communication with said first microprocessor.
63. The integrated communication system of claim 62 further comprising an  
15 inaudible warning device coupled to said head-mounted frame.
64. The integrated communication system of claim 62 wherein said micro-optical display contains a collapsible safety cage.
- 20 65. The integrated communication system of claim 62 further comprising:  
a wearable unit supported by the body of a user;  
a second microprocessor located within said wearable unit, said second microprocessor in wireless communication with said first microprocessor;  
and  
25 a storage system located within said wearable unit in communication with said second microprocessor.
66. The integrated communication system of claim 65 further comprising a body  
mounted sensor in communication with said second microprocessor.

67. The integrated communication system of claim 65 wherein said second microprocessor is configured to wirelessly communicate with emergency support services.

5 68. A personal head-mounted information display comprising:  
a head-mounted support; and  
an ambient light micro-character display coupled to said head-mounted support,  
said ambient light micro-character display configured to utilize  
10 ambient light to illuminate information displayed by said ambient light micro-character display.

69. The information display of claim 68 further comprising:  
an auxiliary lighting source in optical communication with said  
15 micro-character display; and  
a means for controlling said auxiliary lighting source.

70. The information display of claim 68 further comprising an elliptical mirror in optical communication with said micro-character display.

20

71. The information display of claim 68 wherein said ambient light micro-character display is a transmissive liquid crystal display.

72. An integrated communication system for a user comprising:  
25 eyewear having a temple and an eyewire;  
a micro-optical display mounted to said eyewear;  
a first wireless transmitter mounted to the user;  
a first wireless receiver mounted to said eyewear;  
a second wireless receiver mounted to the user;  
30 a second wireless transmitter mounted to said eyewear;



- a microphone mounted to said eyewear;  
a power source mounted to said eyewear in electrical communication  
with said first wireless receiver; and  
a power source supported by the user in electrical communication  
5 with said second wireless receiver.

73. The integrated communication system of claim 72 further comprising a  
speaker mounted to said eyewear.

- 10 74. The integrated communication system of claim 72 wherein said first wireless  
transmitter is adapted to communicate with emergency support services.

75. A method of displaying information to a user comprising:

- (a) displaying a first line of characters on a micro-optical display  
15 mounted to the user's eyewear, said micro-optical display having a micro-character  
display;  
(b) projecting the first line of characters with an optical element to  
position the first line of characters in the field of vision of the user.

- 20 76. The method of displaying information of claim 75 wherein the location of  
said optical element within said micro-optical display adjustable to alter the focus of  
the first line of characters being displayed.

77. The method of displaying information of claim 75 wherein the first line of  
25 characters scrolls across said micro-character display.

78. The method of displaying information of claim 75 further comprising:  
(c) displaying a second line of characters on said micro-optical display.

30

79. The method of displaying information of claim 75 further comprising:  
(c) storing information in a storage device in communication with said micro-optical display, said storage device being supported by the user.
- 5 80. A method of personal communication utilizing the eyewear of a user comprising:  
(a) sending an information stream from a control unit supported by the user over a wireless channel to a receiving unit coupled to the user's eyewear; and,  
(b) displaying a first line of characters conveyed in the information  
10 stream on a micro-optical display coupled to the user's eyewear.
81. The method of personal communication of claim 80 further comprising:  
(c) extracting audio data from the information stream; and  
(d) reproducing the audio data so that it is audible to the user.  
15
82. The method of claim 81 wherein step (d) includes translating the audio data from a first spoken language to a second spoken language.
83. The method of claim 81 wherein step (b) further comprises displaying a  
20 second line of character's from the information stream on said micro-optical display.
84. The method of personal communication of claim 81 wherein the information stream contains information received from a wireless network.
- 25 85. The method of claim 81 further comprising:  
(e) receiving audio data from the user; and  
(f) transmitting the audio data over a wireless network.
86. Eyewear having a main lens comprising:  
30 a focusing lens mounted to the main lens; and

an organic light emitting diode mounted to the main lens, the organic light emitting diode in optical communication with said focusing lens.

5 87. The eyewear of claim 86 wherein said focusing lens is a refractive lens.

88. The eyewear of claim 86 wherein said focusing lens is an electro-active refractive lens.

10 89. The eyewear of claim 86 wherein said focusing lens is a detractive lens.

90. The eyewear of claim 86 wherein said organic light emitting diode is adapted to be transparent when not in use.

15 91. Eyewear for a user comprising:  
a temple;  
an eyewire coupled to said temple; and  
a micro-optical display coupled to said eyewire.

20 92. The eyewear of claim 91 further comprising a lens positioned on said eyewire, said lens notched to accommodate said micro-optical display.

93. The eyewear of claim 91 wherein said micro-optical display contains an optical element that is adapted to correct a portion of the refractive error of the user.

25 94. The eyewear of claim 91 wherein said micro-optical display is pivotably coupled to said eyewire.

30 95. An integrated communication system for a user comprising:  
eyewear containing a micro-optical display and a first micro-processor; and,

a remote unit containing a second micro-processor,  
said remote unit adapted to be supported by the user,  
said second micro-processor in wireless communication with said  
first micro-processor.

5

96. The integrated communication system of claim 95 wherein said eyewear  
further comprises:

a first eyewire;

a second eyewire; and,

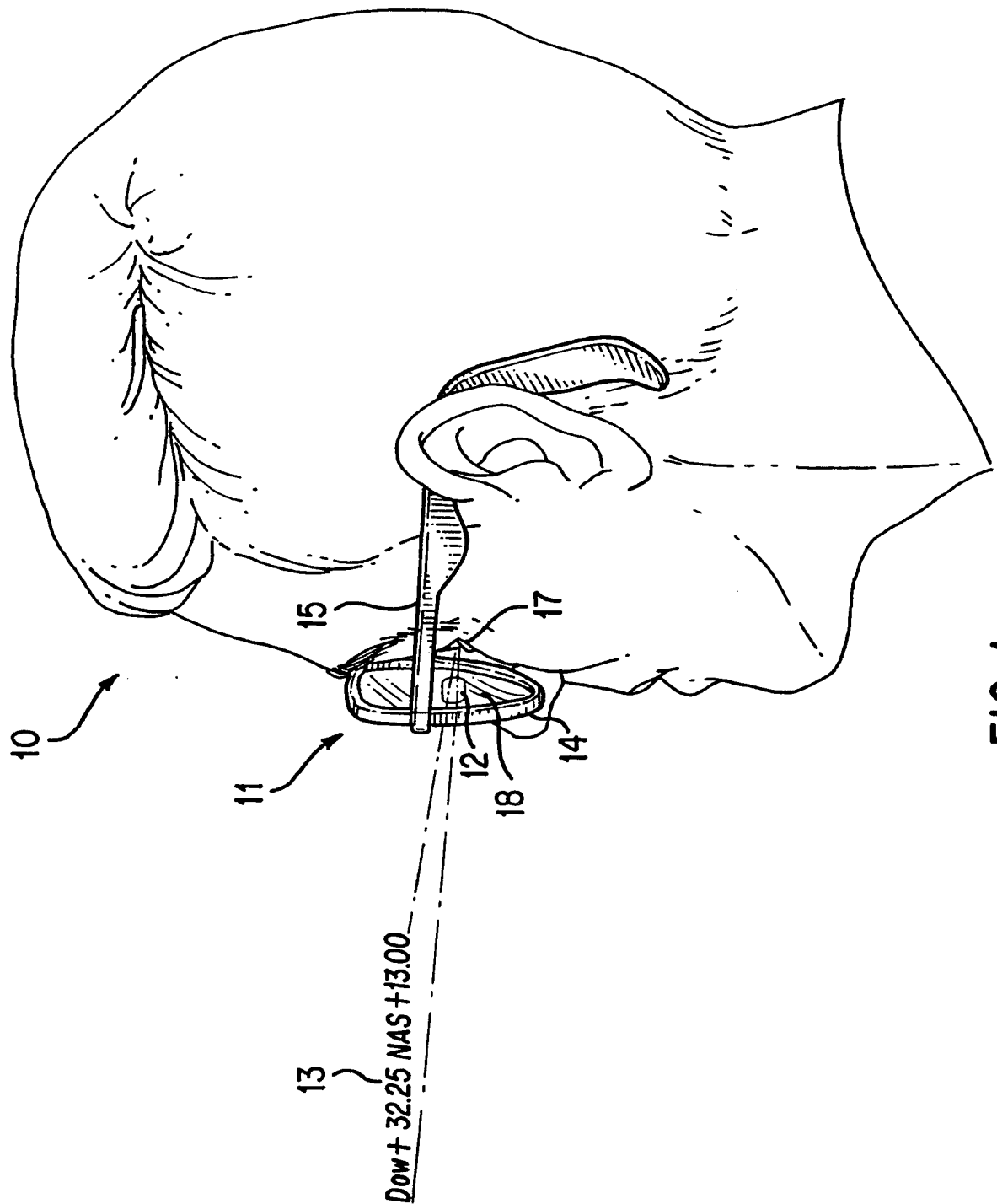
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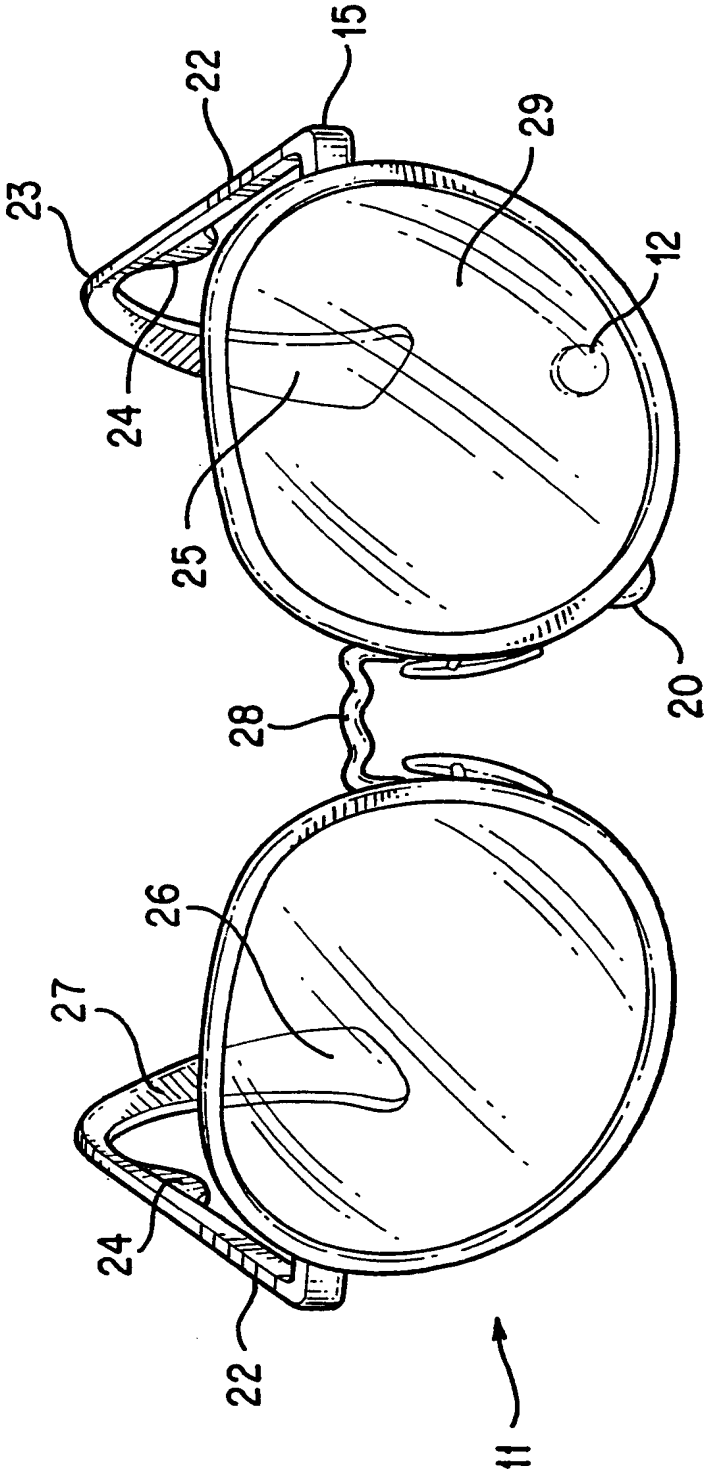
a bridge connecting said first eyewire and said second eyewire.

97. The integrated communication system of claim 95 wherein said remote unit  
is adapted to translate a first spoken language into a second spoken language.

15

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HELLO, YOU GOT MAIL

FIG. 2.1

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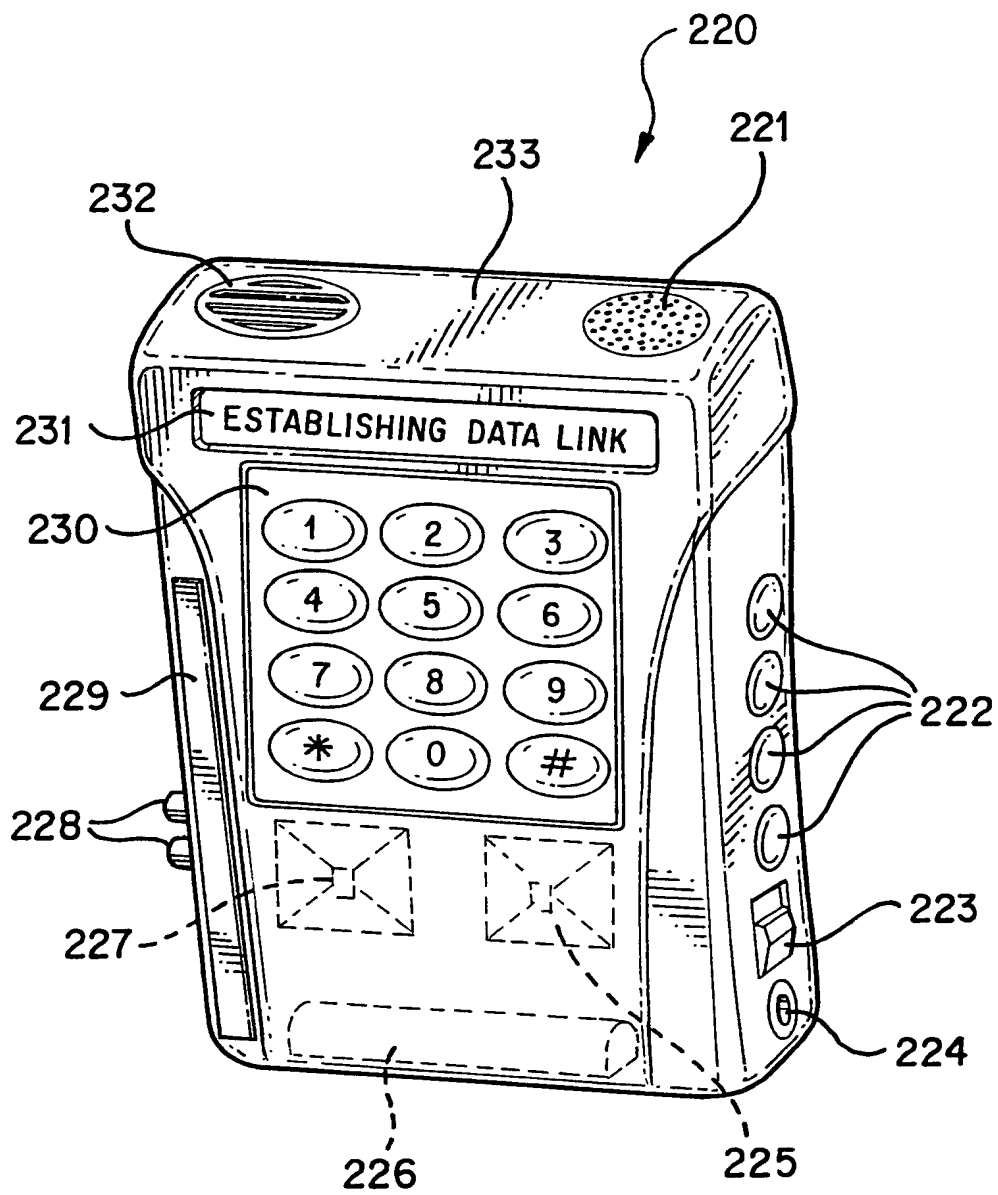
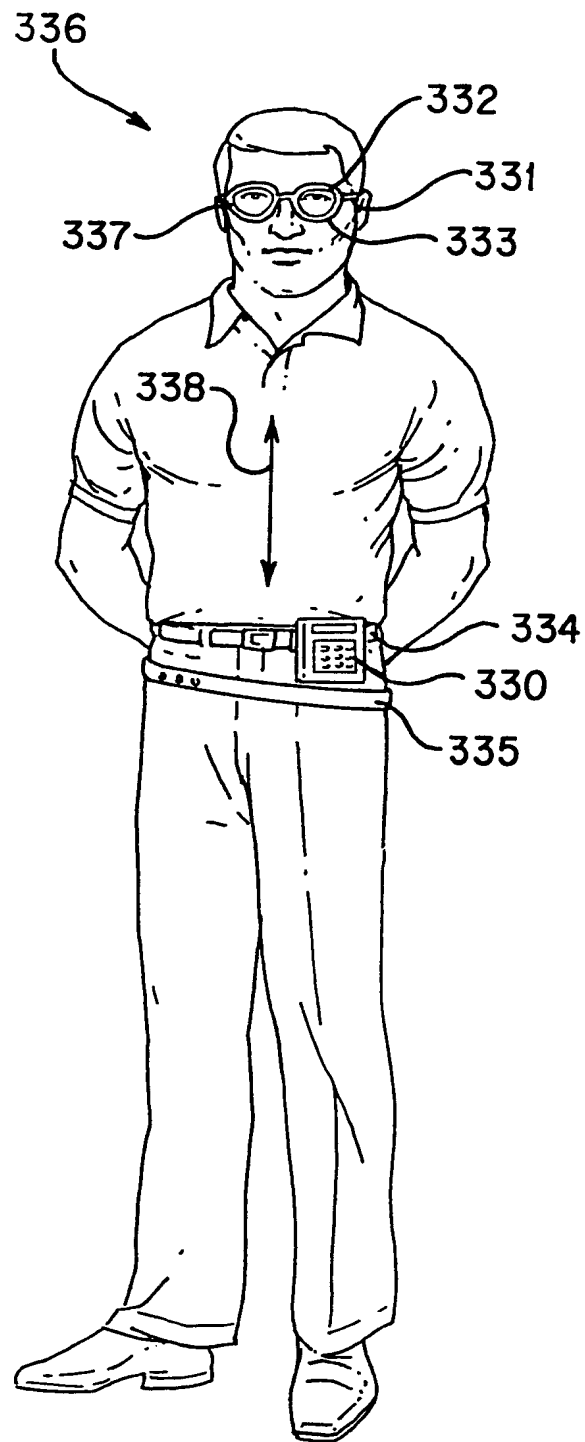


FIG. 2.2

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**FIG. 2.3**



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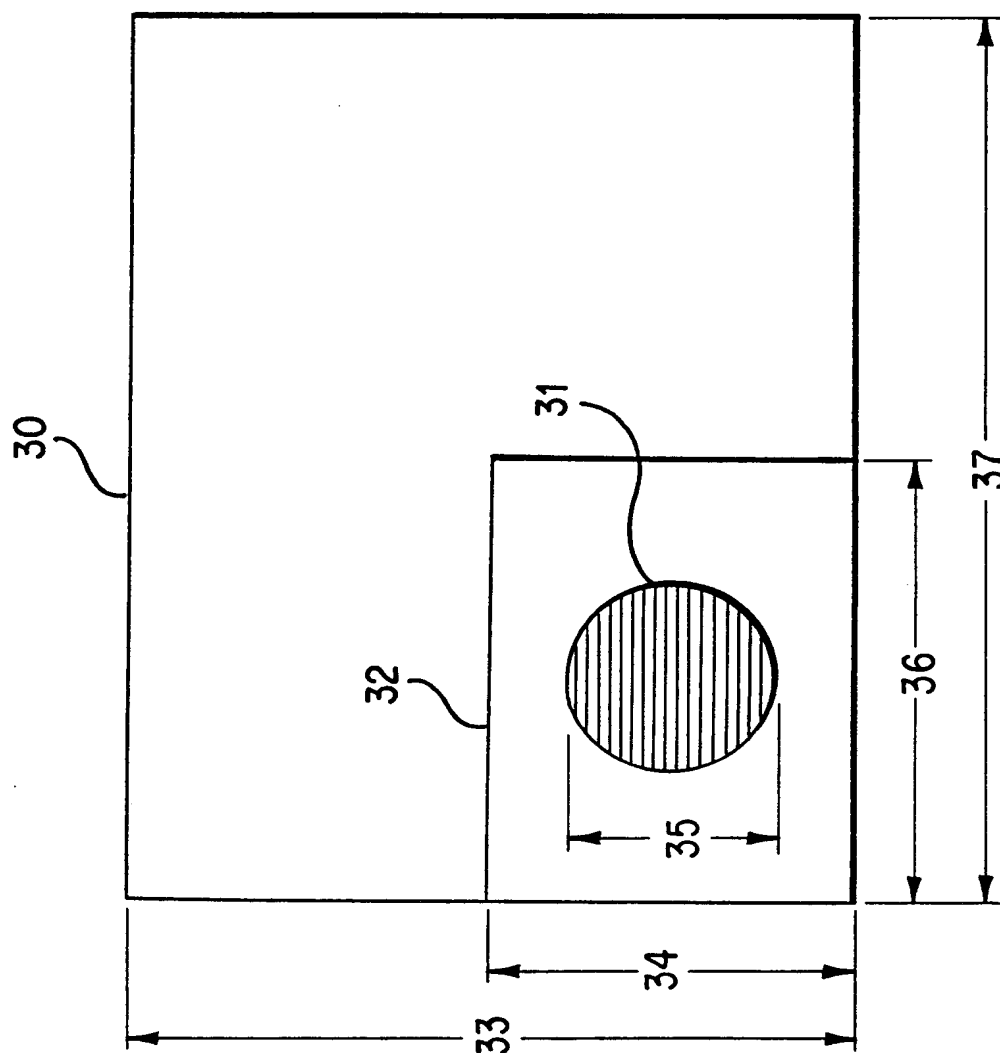


FIG. 3

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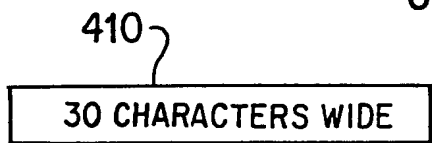


FIG. 4.0

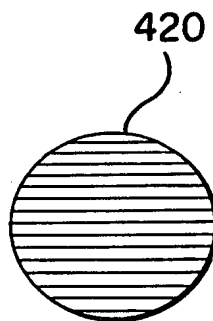


FIG. 4.1

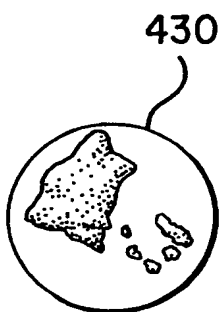


FIG. 4.2

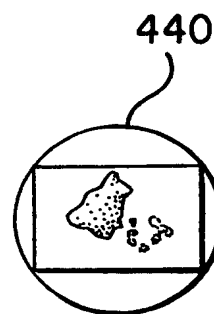


FIG. 4.3

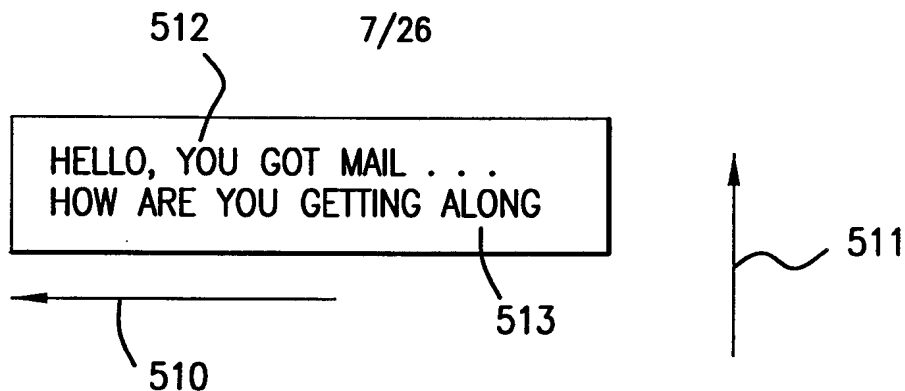


FIG.5.0

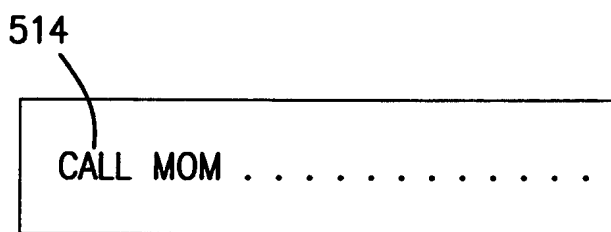


FIG.5.1

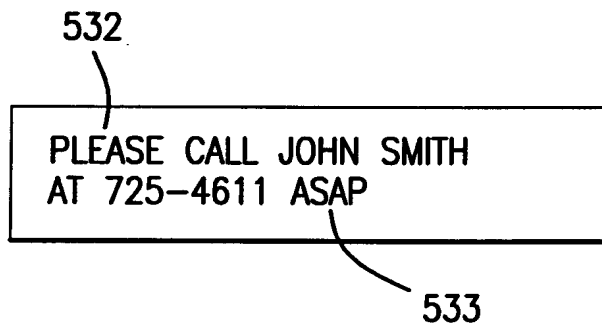


FIG.5.2

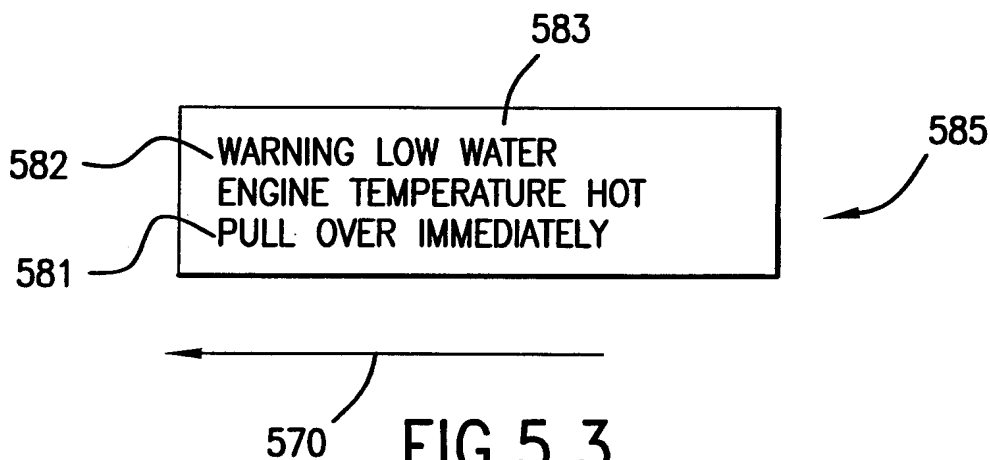


FIG.5.3

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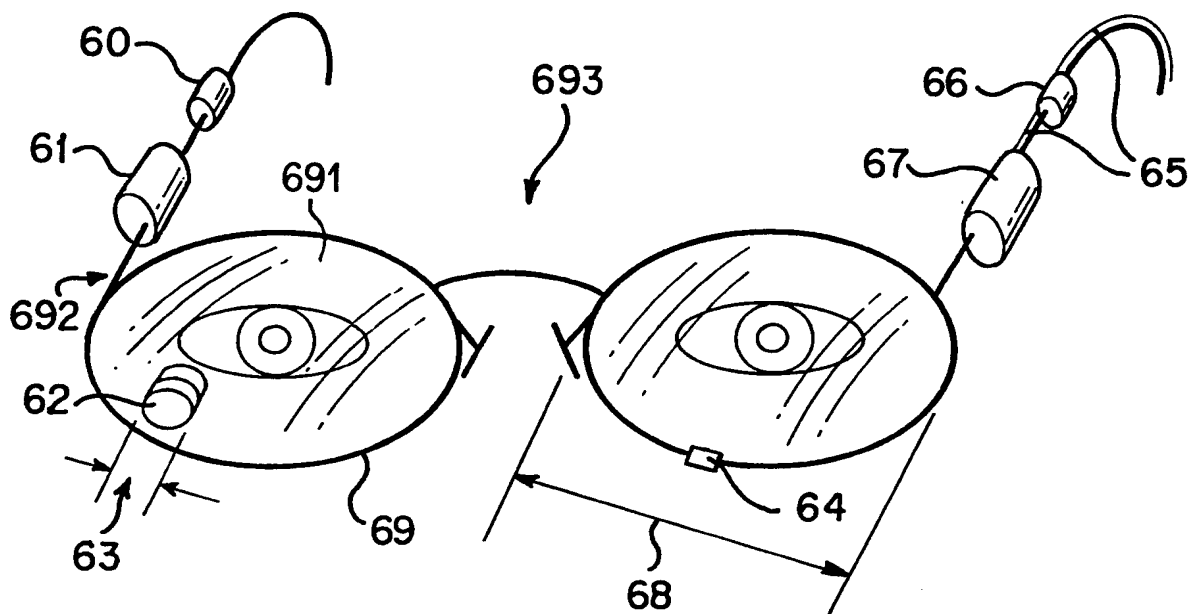


FIG. 6

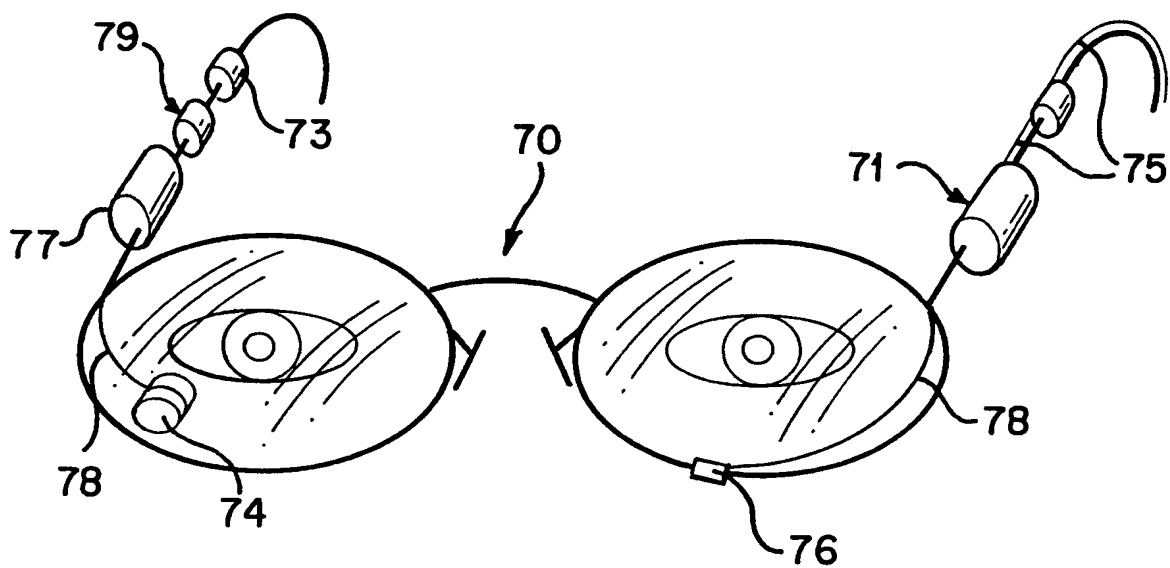


FIG. 7

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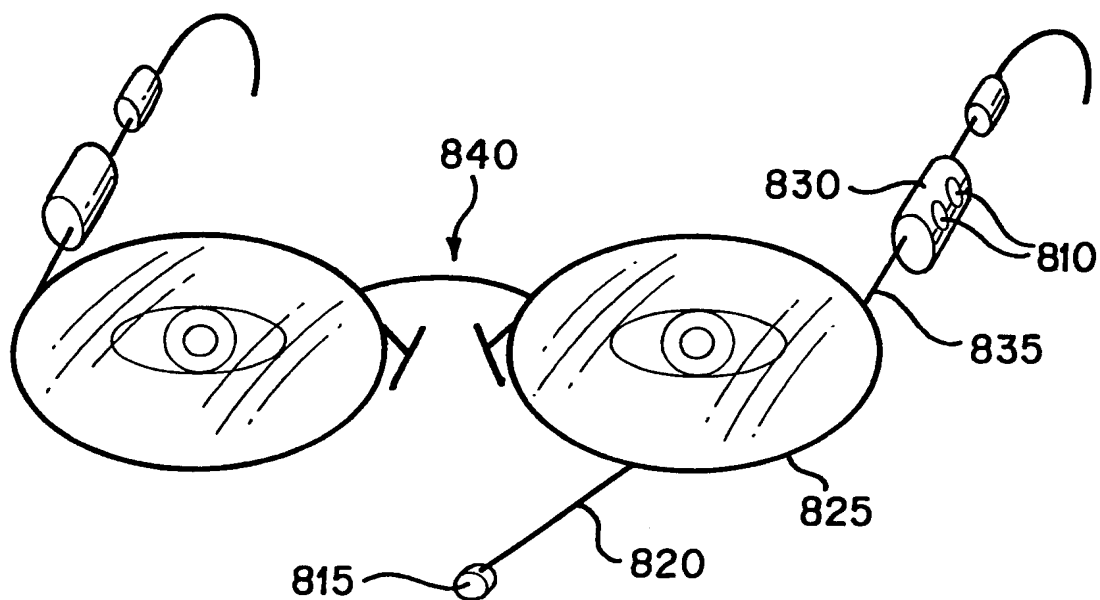


FIG. 8

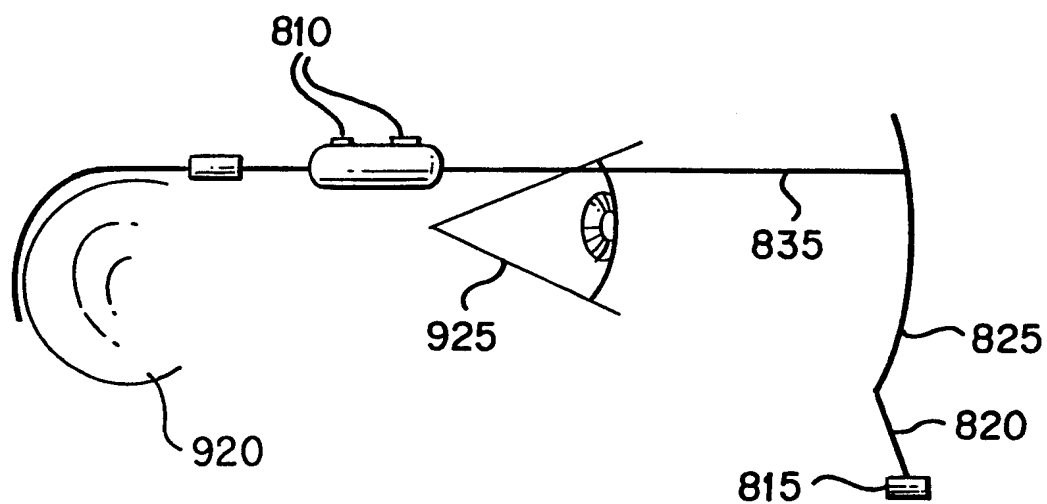


FIG. 9

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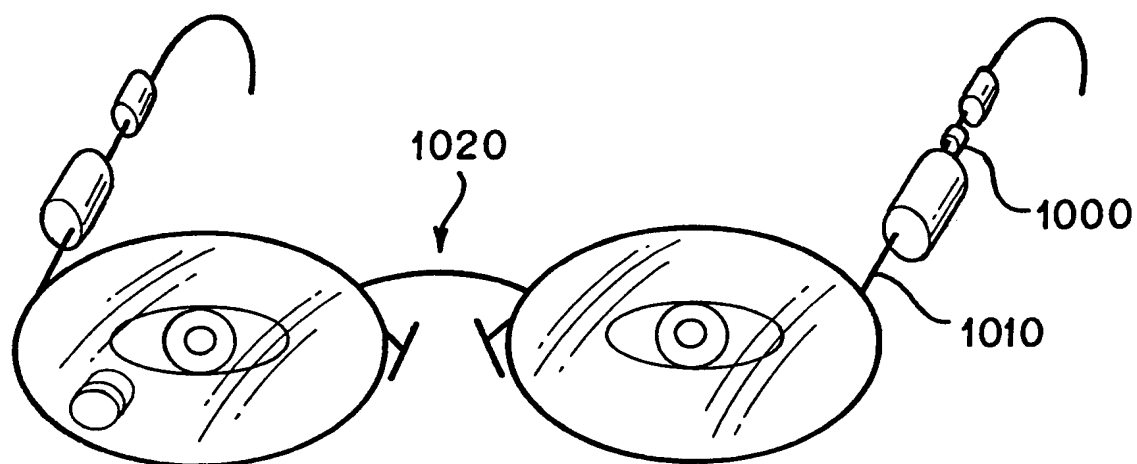


FIG. 10

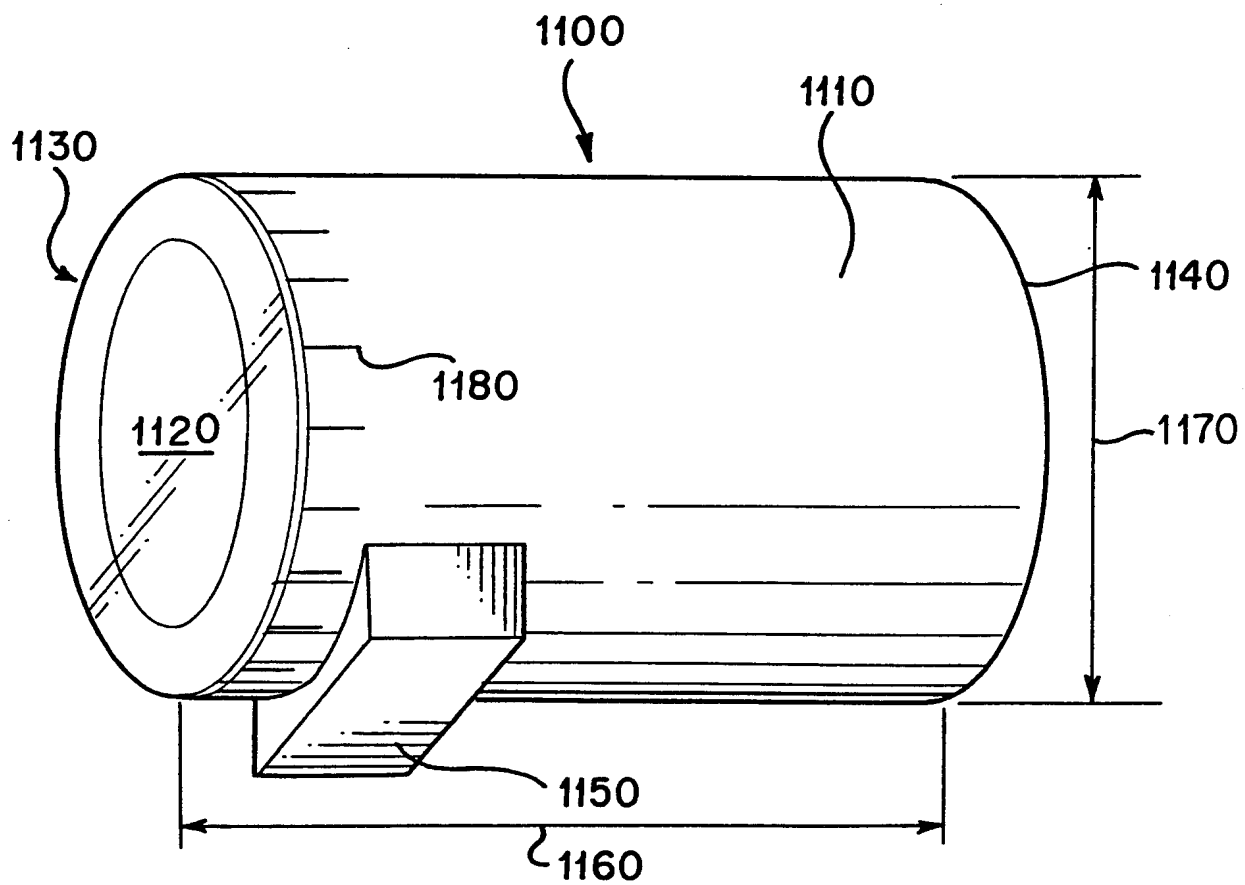


FIG. 11

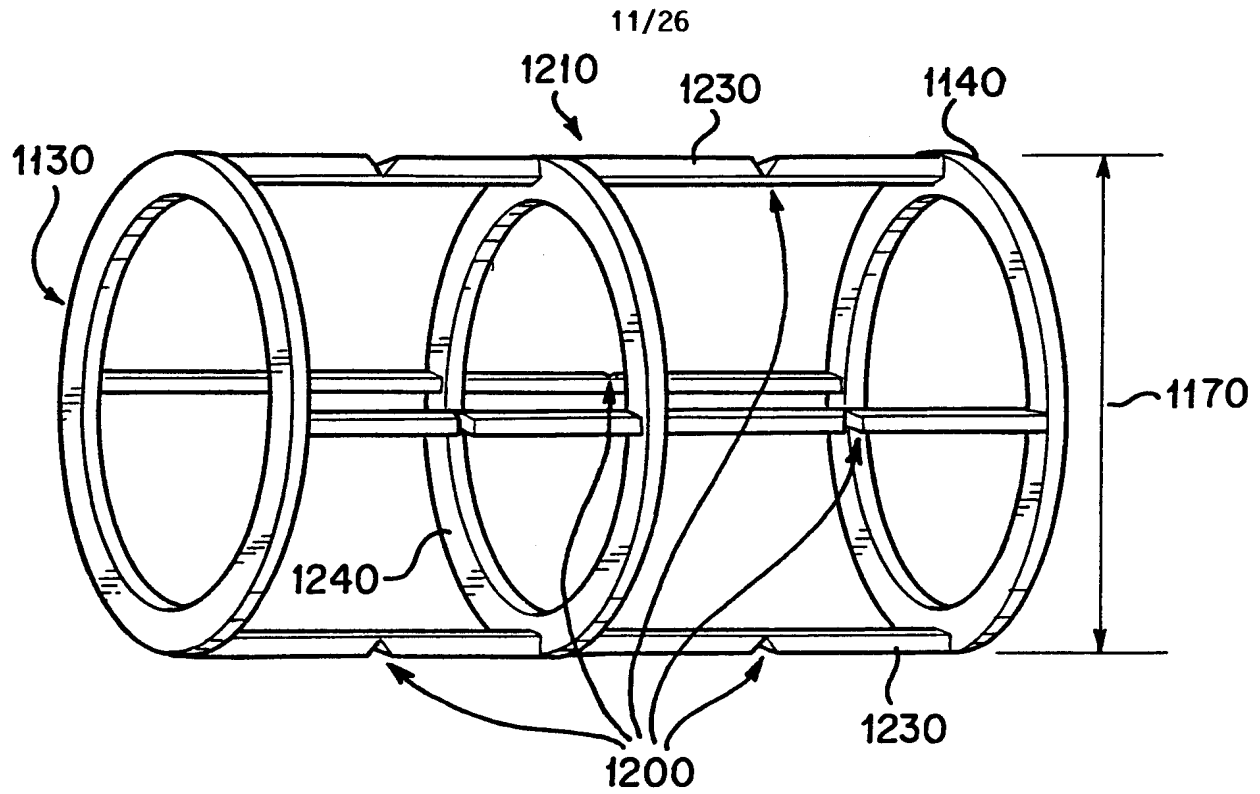


FIG. 12

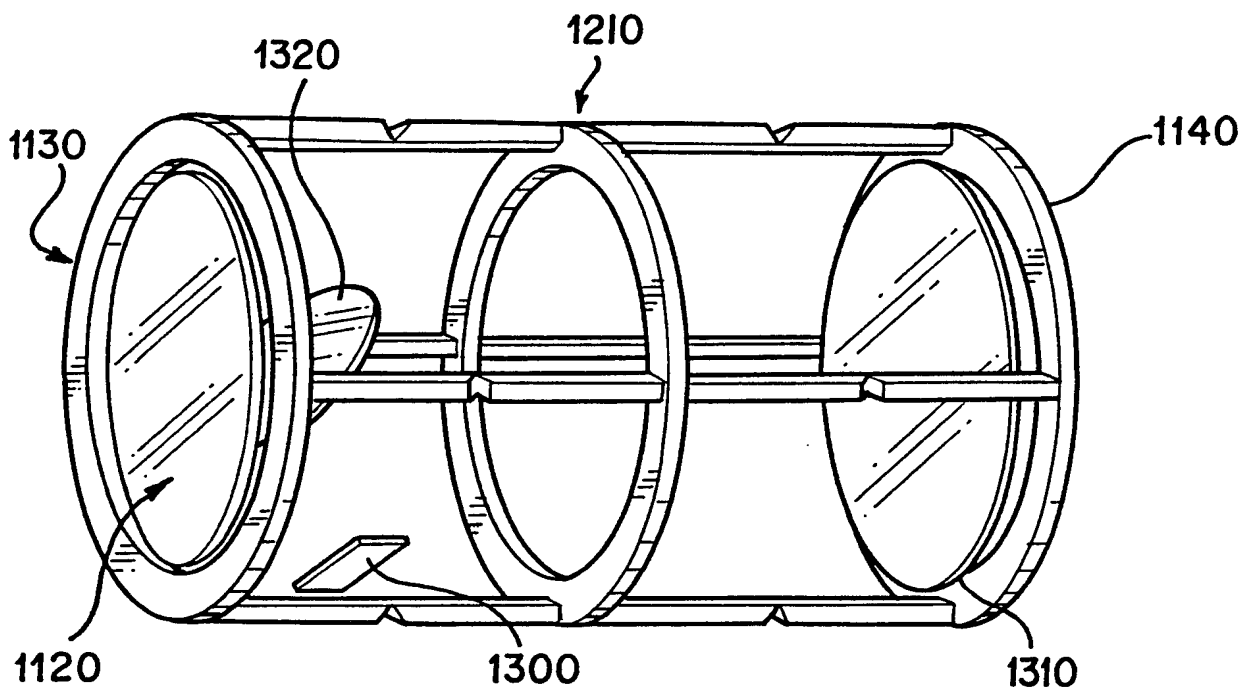


FIG. 13

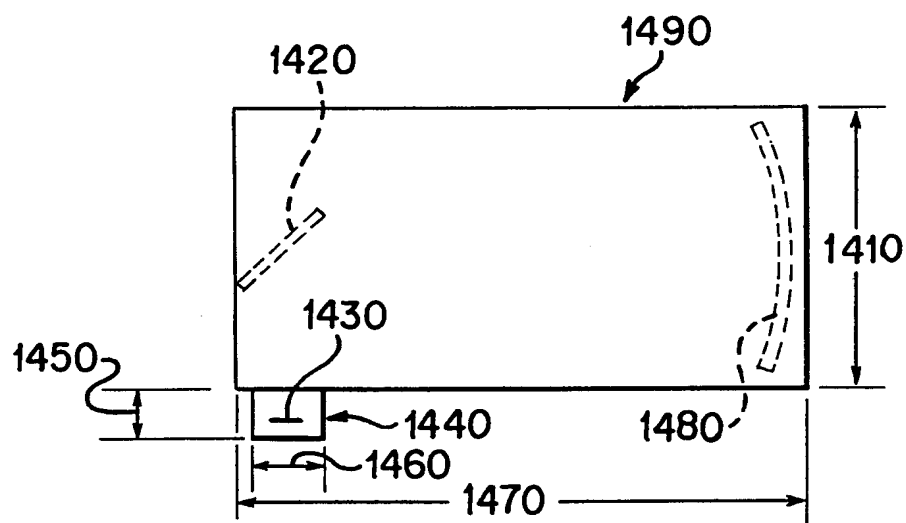


FIG. 14

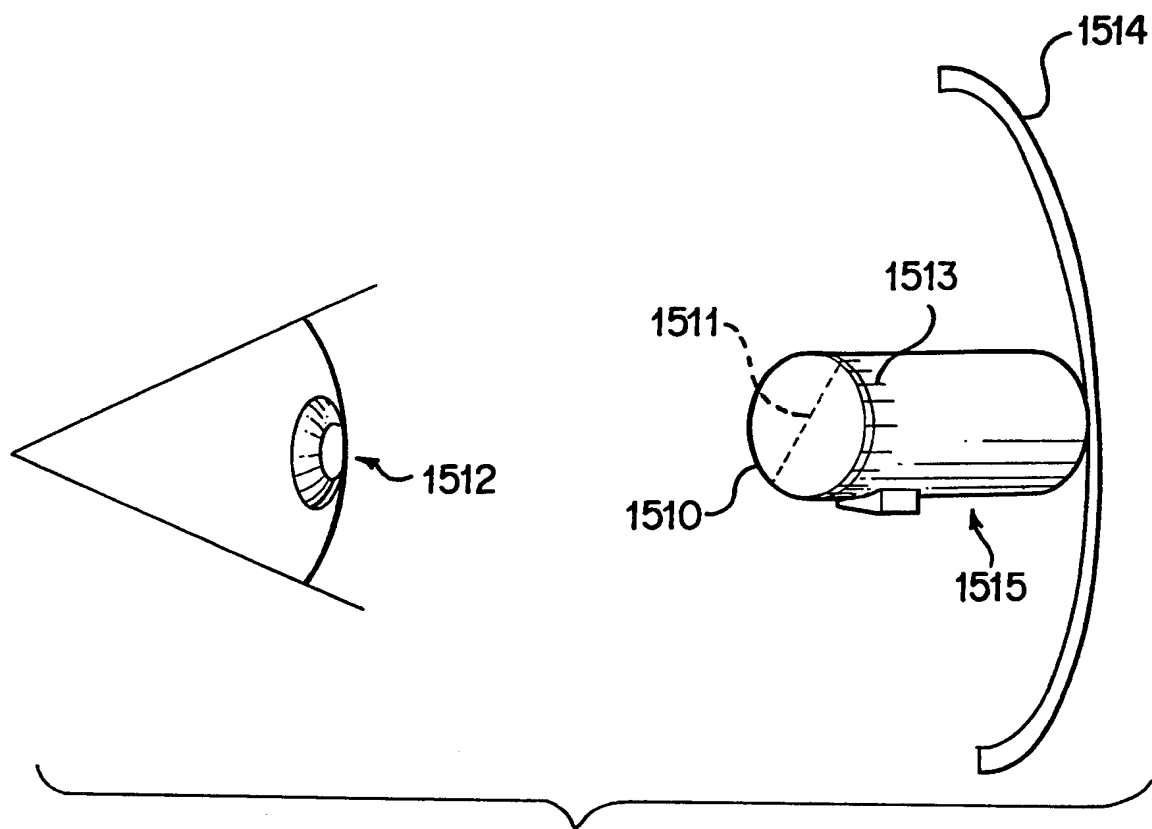


FIG. 15.0



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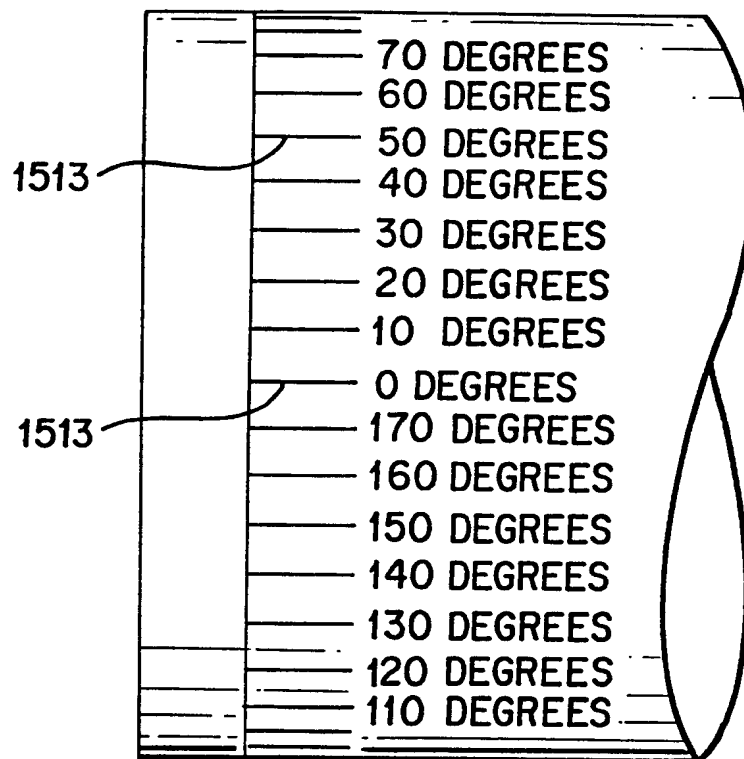


FIG. 15.1

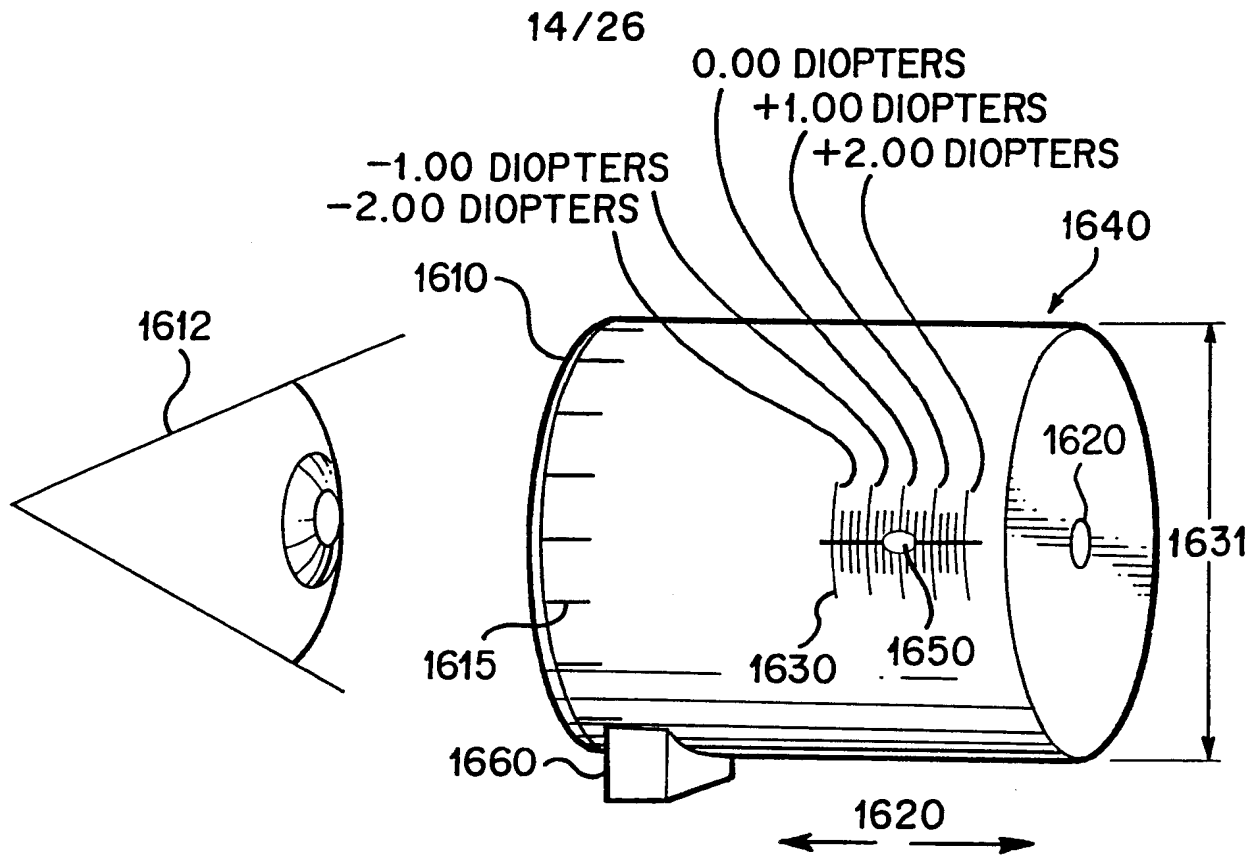


FIG. 16.0

MIRROR ADJUSTMENT (mm)	DIOPTERS
0.0	0.0
0.1	1.0
0.2	2.0
0.3	3.0
0.4	4.0
0.5	5.0
0.6	6.0
0.7	7.0
0.8	8.0
0.9	9.0
1.0	10.0

FIG. 16.1

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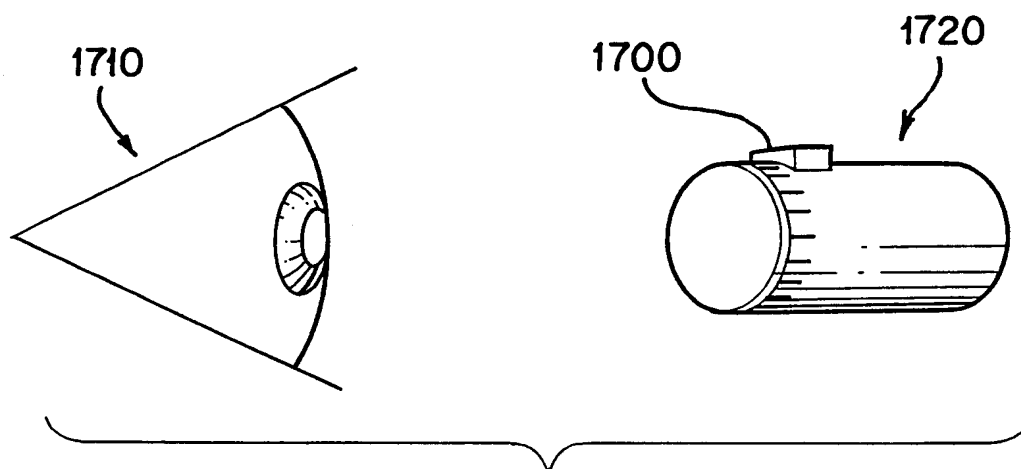


FIG. 17

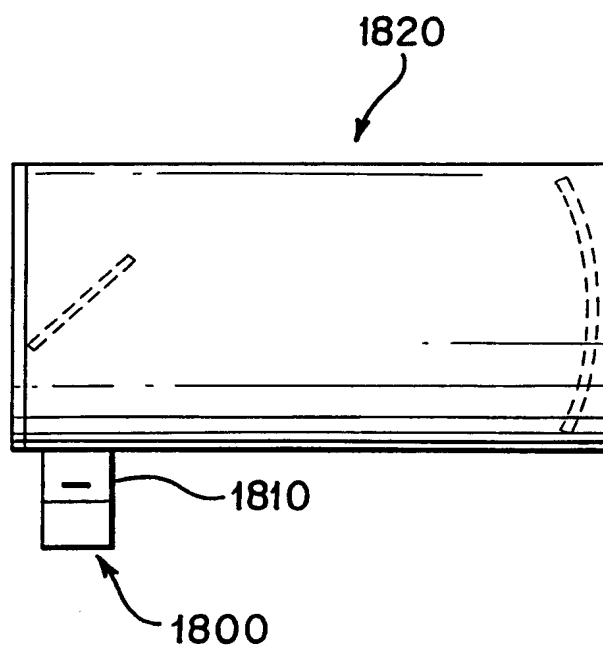


FIG. 18.0

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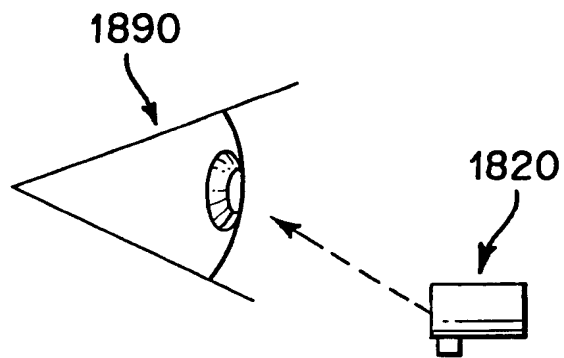


FIG. 18.1

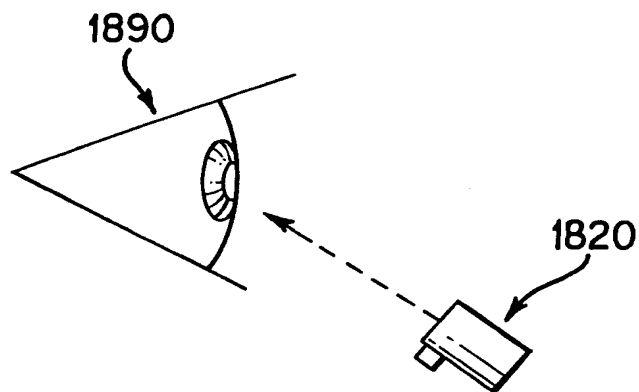


FIG. 18.2

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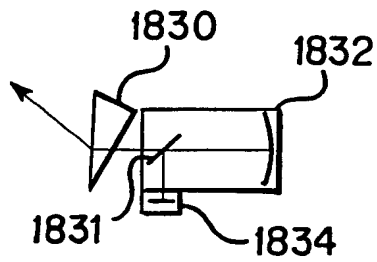


FIG. 18.3

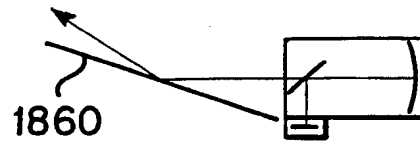


FIG. 18.6

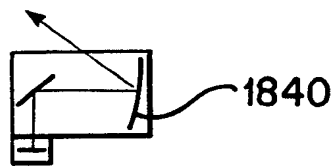


FIG. 18.4

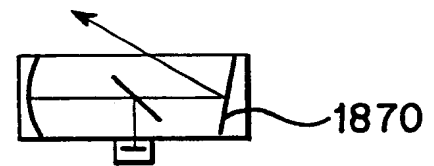


FIG. 18.7

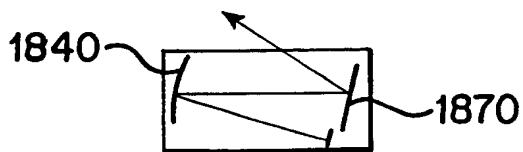


FIG. 18.5

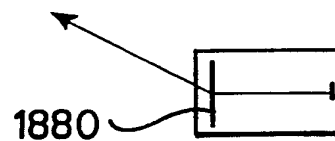


FIG. 18.8

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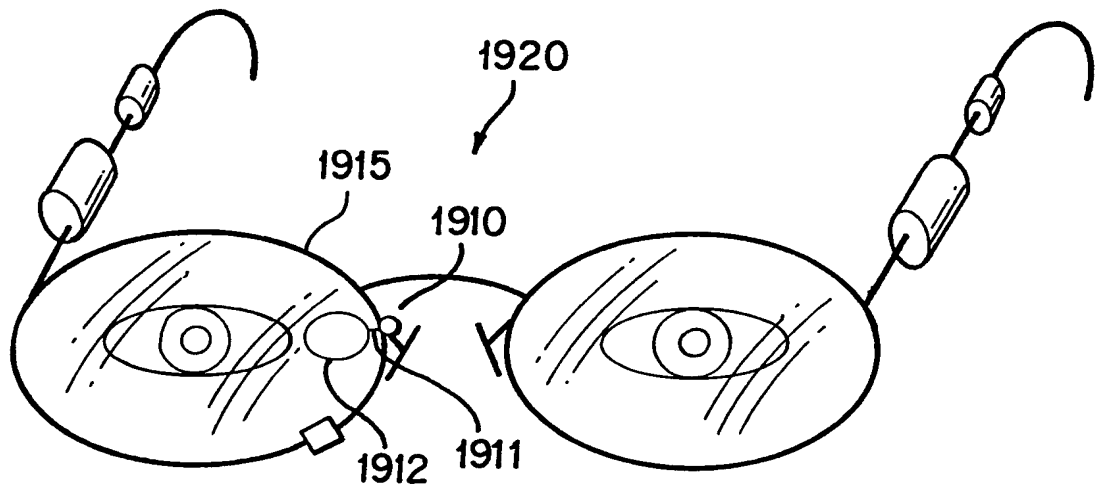


FIG. 19

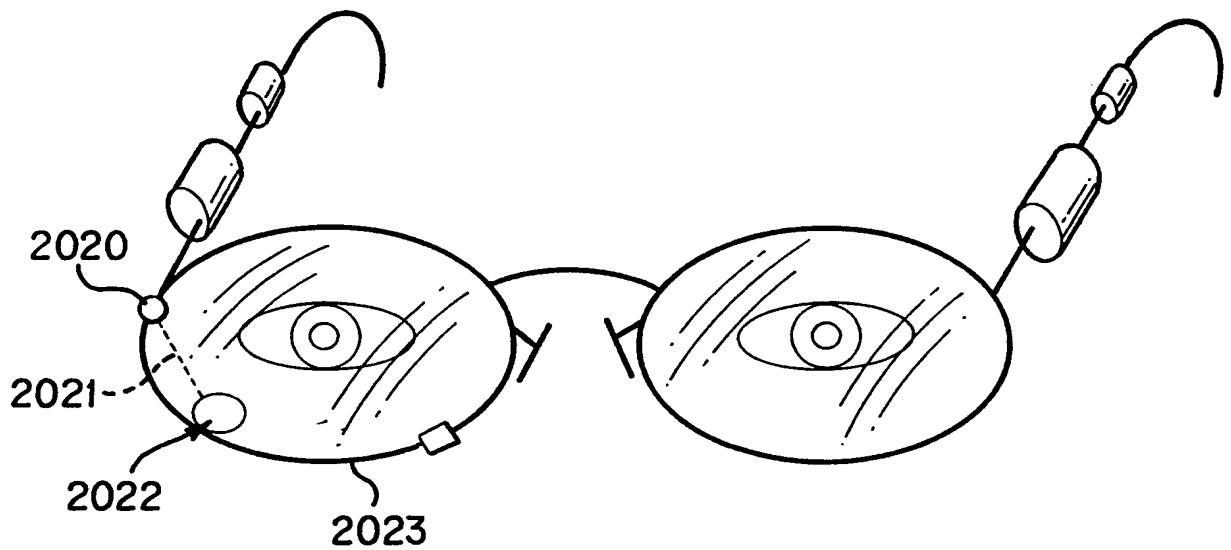


FIG. 20

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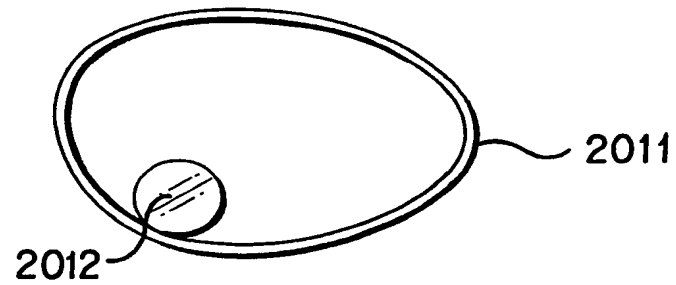


FIG. 20.1

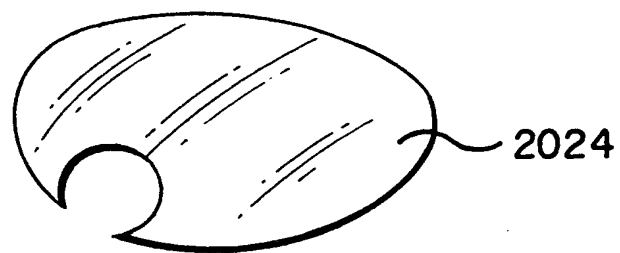


FIG. 20.2

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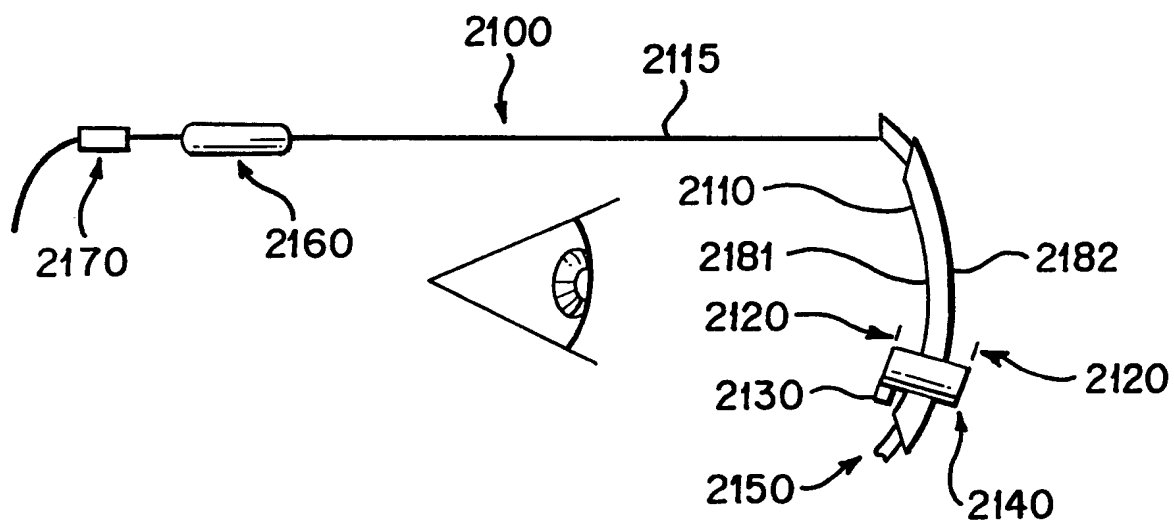


FIG. 21

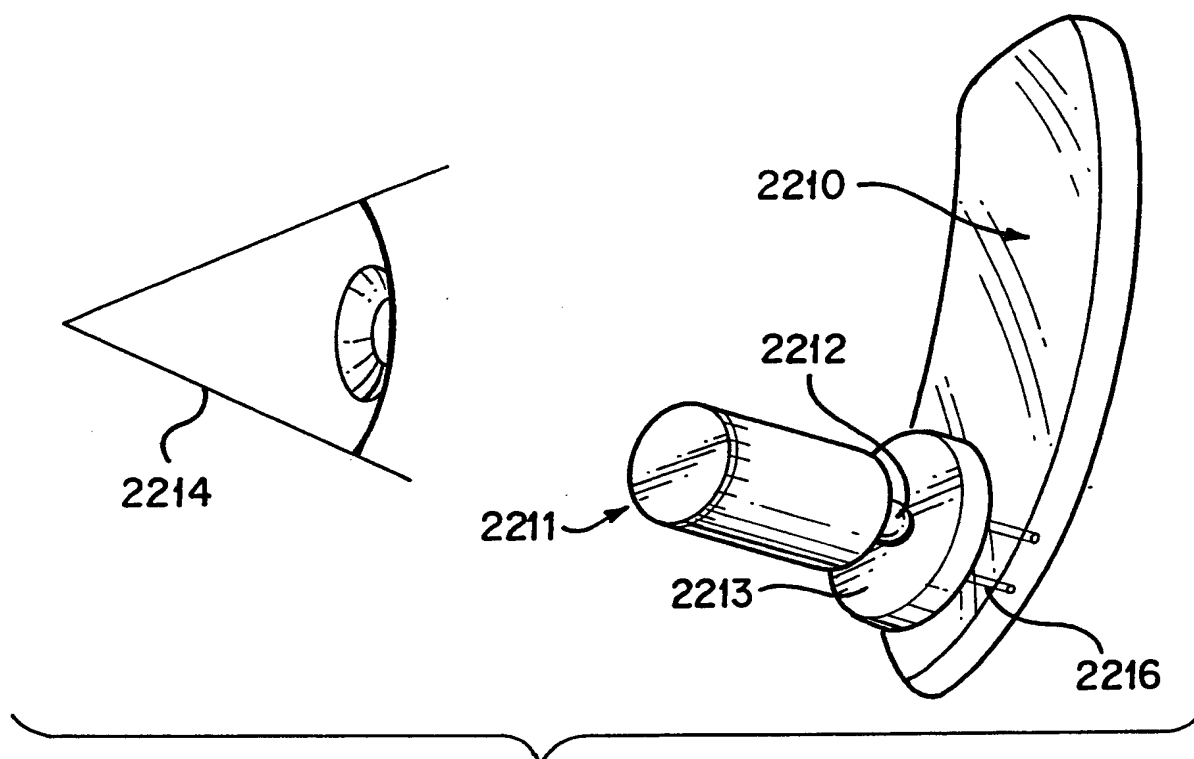


FIG. 22



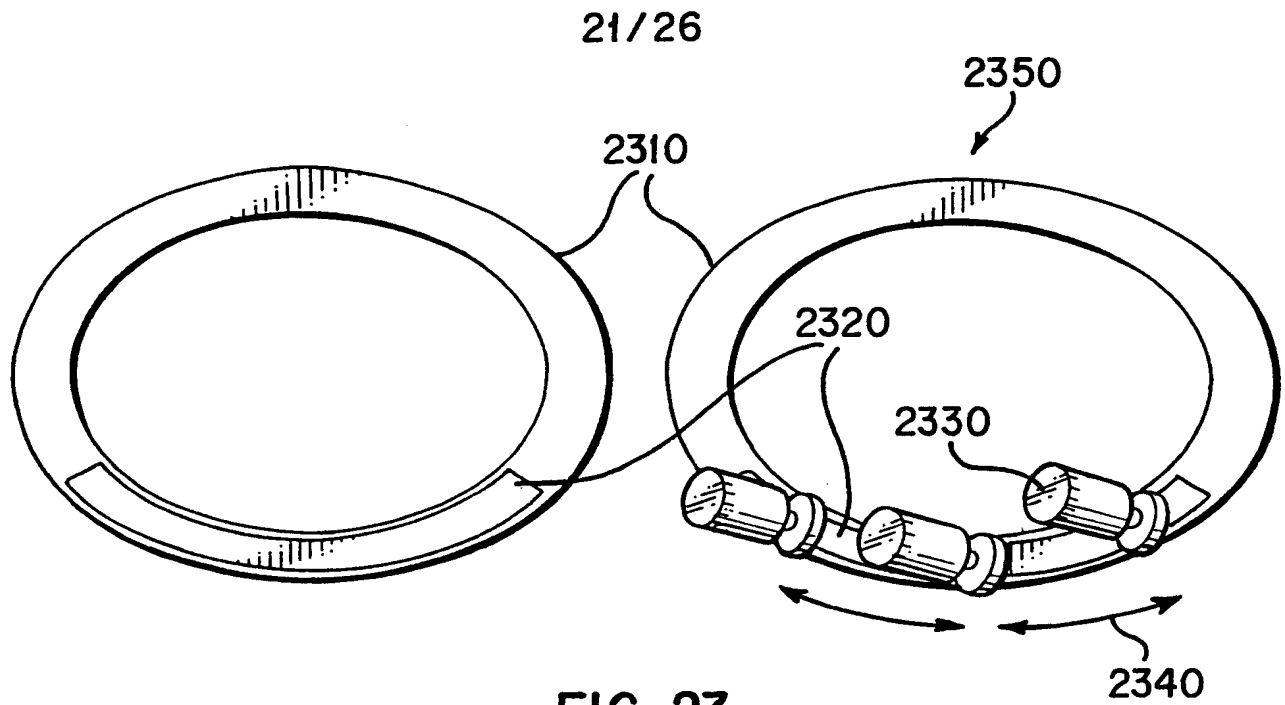


FIG. 23

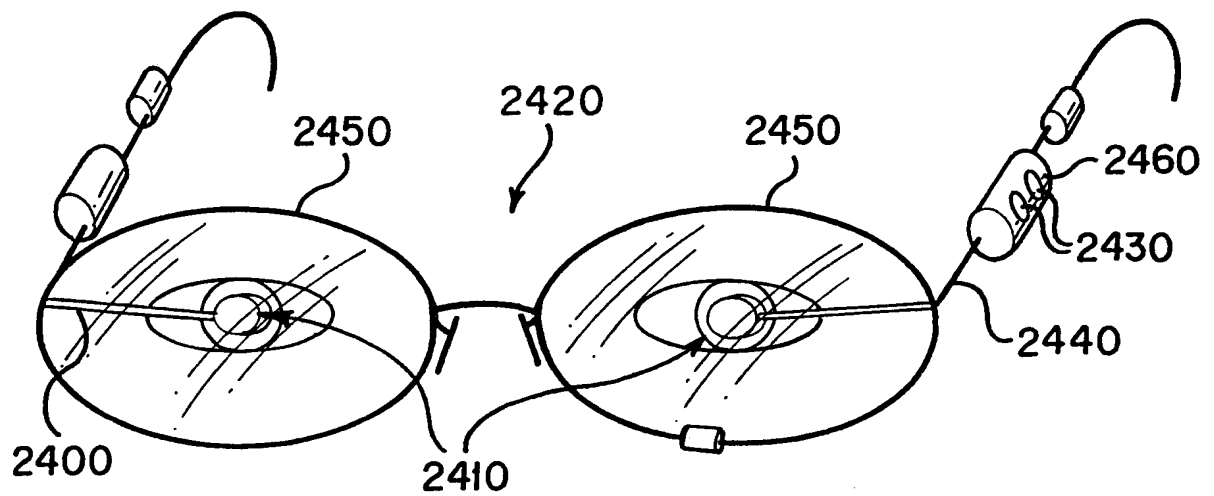


FIG. 24

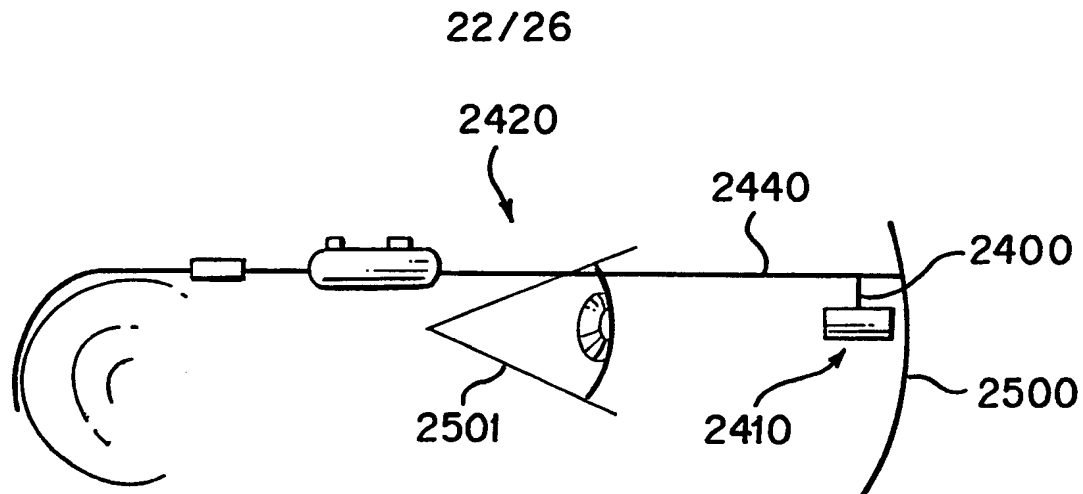


FIG. 25.0

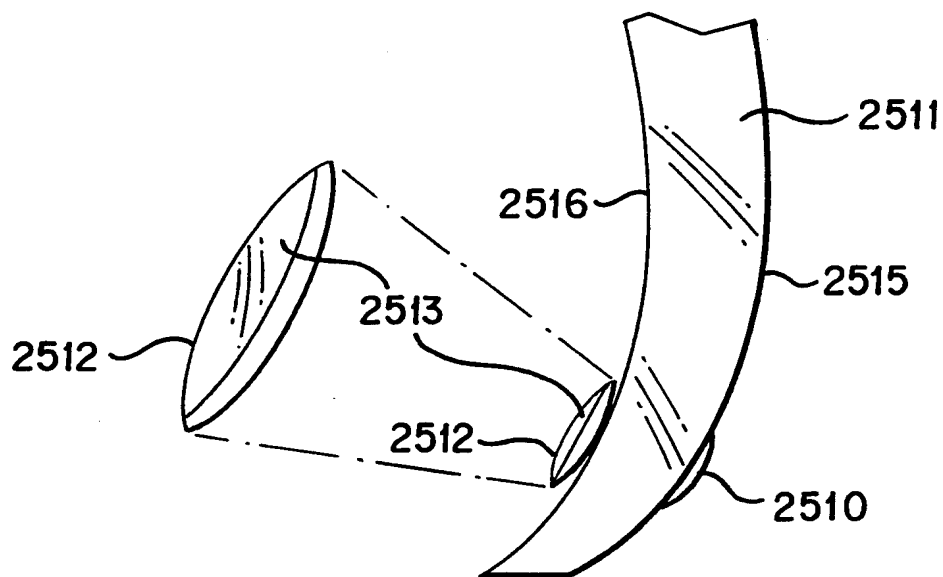


FIG. 25.1

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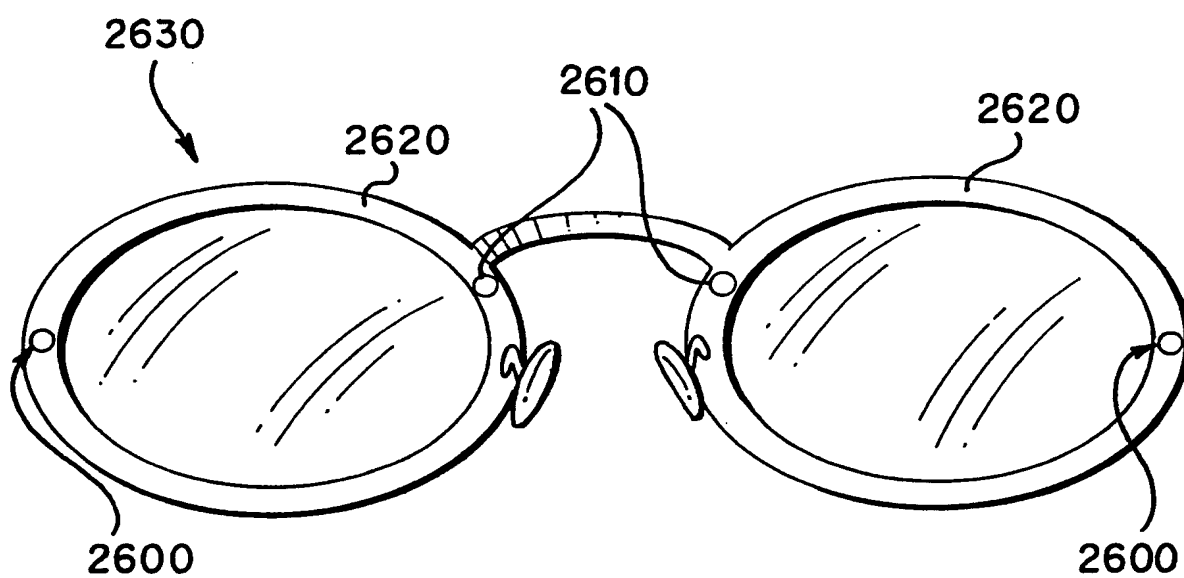


FIG. 26

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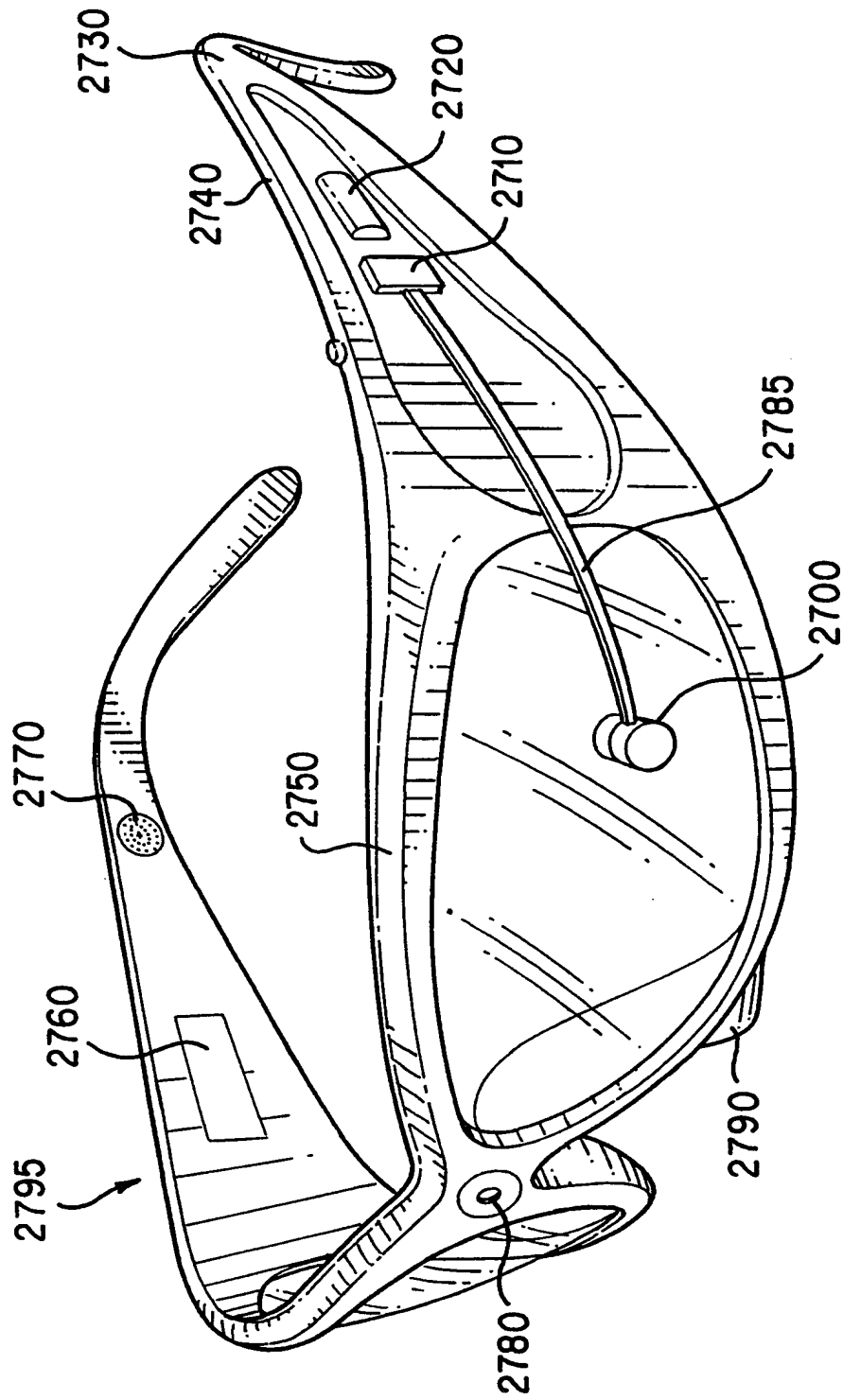


FIG. 27

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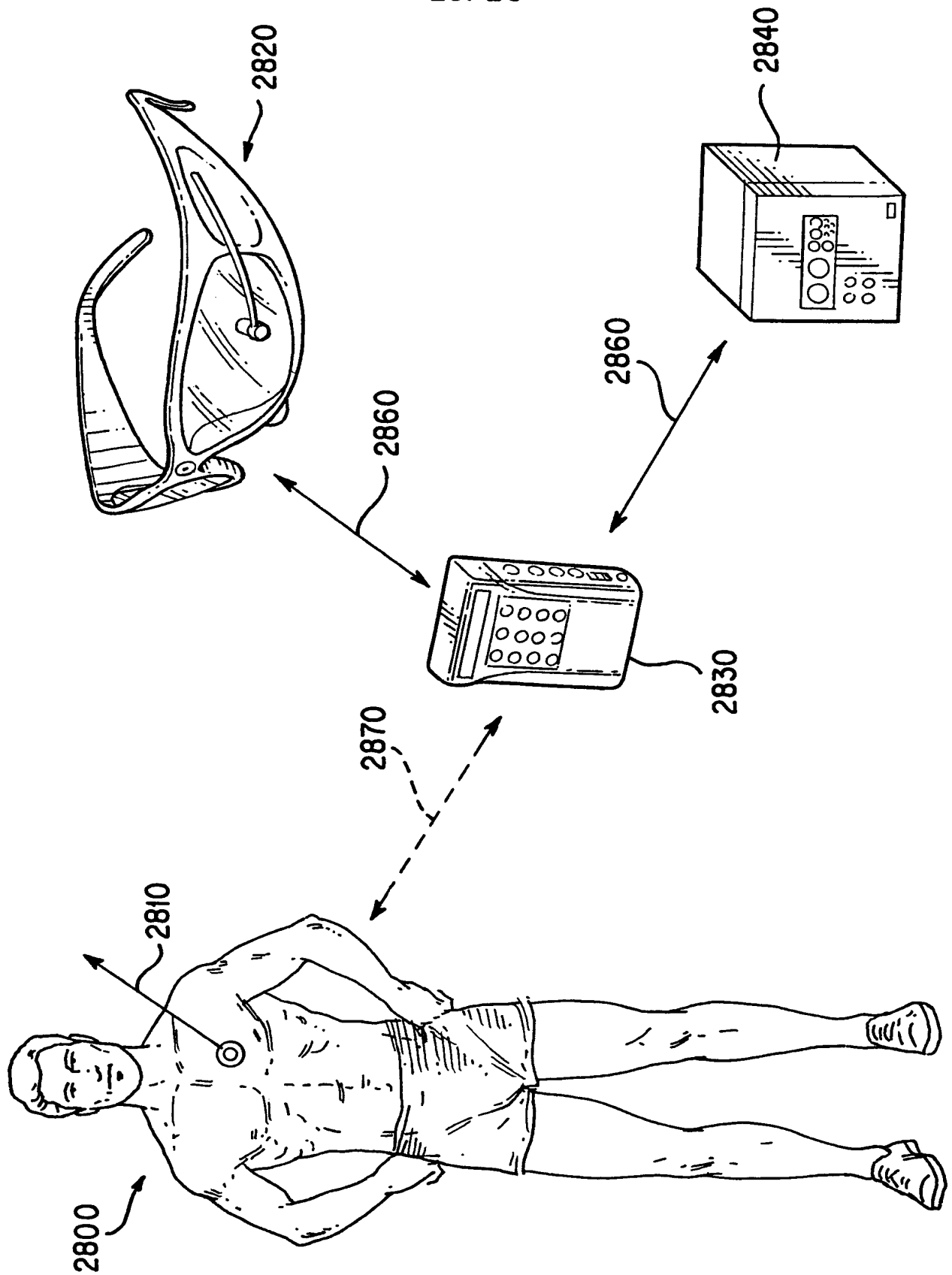


FIG. 28

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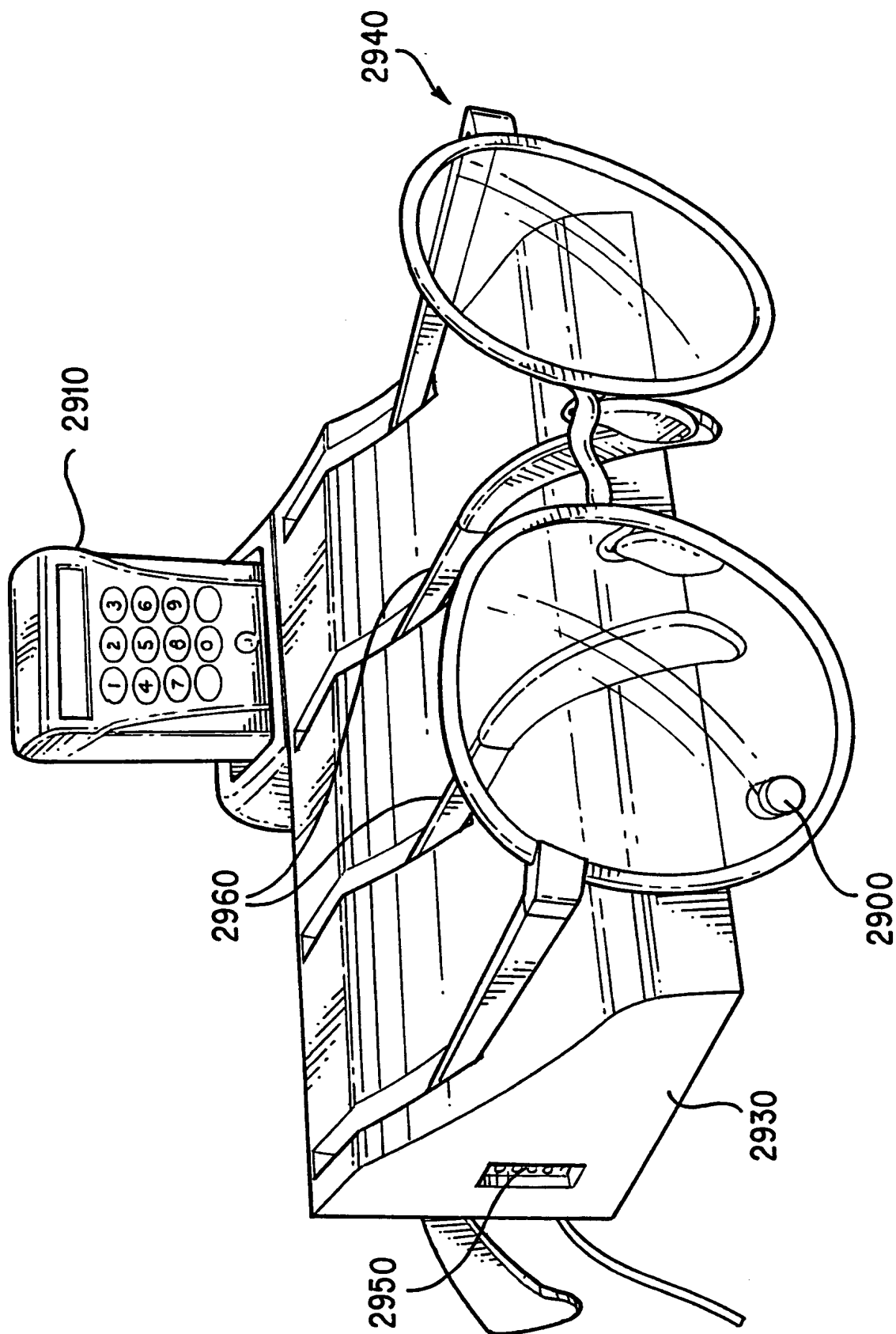


FIG. 29

## INTERNATIONAL SEARCH REPORT

 International application No.  
PCT/US00/19419
**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(7) : GO2B 27/00; GO2C 1/00; G09G 5/00

US CL : 359/637, 630, 819; 351/158, 123; 345/8

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 359/637, 630, 819, 618, 633, 823, 612; 351/158, 123, 113, 50, 58, 176, 178; 345/8

 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched  
NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WEST: eyewear and eyewire and micro

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A,E	US 6,091,546 A (SPITZER) 18 July 2000, (18/07/00) col. 4, line 11 to col. 12, line 18.	1-54, 62, 63, 68-81, 83-96
A	US 5,606,743 A (VOGT et al) 25 February 1997, (25/02/97) col. 4, line 3 to col. 11, line 54.	1-54, 62, 63, 68-81, 83-96
A,P	US 6,010,216 A (JESIEK) 04 January 2000, (04/01/00) col. 1, line 32 to col. 4, line 58.	52, 53
A,P	US 6,012,812 A (RIKARDS) 11 January 2000, (11/01/00) col. 5, line 31 to col. 9, line 52.	52, 53

☐ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E" earlier document published on or after the international filing date	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&" document member of the same patent family
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

27 SEPTEMBER 2000

Date of mailing of the international search report

19 OCT 2000

 Name and mailing address of the ISA/US  
Commissioner of Patents and Trademarks  
Box PCT  
Washington, D.C. 20231

Facsimile No. (703) 305-7724

Authorized officer

LOHA BEN

Telephone No. 703-308-4820

# INTERNATIONAL SEARCH REPORT

International application No.

PCT/US00/19419

## Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

Please See Extra Sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.  
☐ No protest accompanied the payment of additional search fees.



## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/US00/19419

### BOX II. OBSERVATIONS WHERE UNITY OF INVENTION WAS LACKING

This ISA found multiple inventions as follows:

This application contains the following inventions or groups of inventions which are not so linked as to form a single inventive concept under PCT Rule 13.1.

Group I, claims 1-51 and 91-94, drawn to a head-mounted viewable display system having correction means, classified in class 359, subclass 637.

Group II, claims 52-85 and 95-97, drawn to an integrated communication system including eyewear, classified in class 351, subclass 158.

Group III, claims 86-90, drawn to an eyewear with lens mount, classified in class 359, subclass 819.

The inventions listed as Groups I-III do not relate to a single inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: Patentability of each invention does not depend on patentability of other inventions. Each invention has acquired a separate status in the art because of their divergent subject matter as pointed out above.